

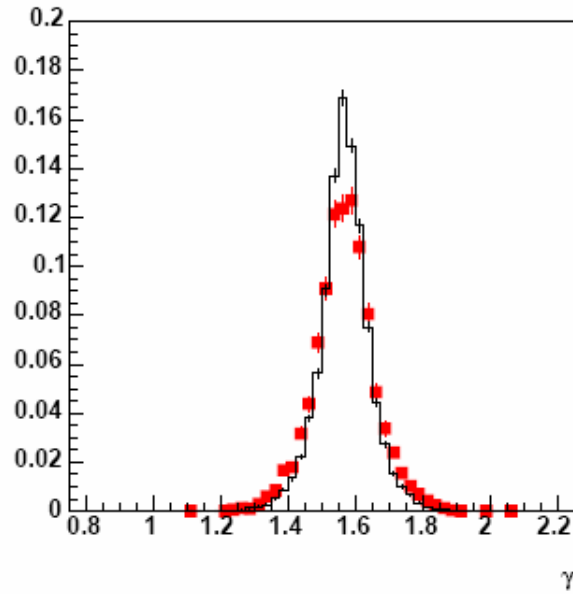
- Remark: most plots here are only for  $D=0.5$ 
  - Plots are similar for  $D=0.7$  and  $1.0$  (see GP web page)
- Bisector Method
  - Raw quantity distributions (Data and MC) → pages 2 to 4
  - Applied at hadron level → page 5
- Dijet Balance
  - Raw quantity distributions (Data and MC) → pages 6 to 10
  - Probe Jet /  $|\eta_{\text{DET}}| < 0.25$  ( $> 0.55$ ) → page 11
  - Probe Jet /  $|\eta_{\text{DET}}| \notin [0.25, 0.55]$  (reference region) → page 12
- Rapidity distributions
  - Discrepancy between data and MC can be explained by above dijet balance results
  - Possible effect: compare unfolded cross sections with the nominal  $0.1 < |Y^{\text{CAL}}| < 0.7$  cut and a  $0.25 < |\eta_{\text{DET}}^{(\text{CAL})}| < 0.55$  cut → page 13
- Absolute  $P_{\text{T}}$  jet correction
  - CAL / HAD matching distributions → pages 14 to 16
  - $P_{\text{T}}$  and  $\Delta P_{\text{T}}$  distributions → pages 17 to 19
- Pile-Up correction
  - Investigate cross sections in  $5 \neq$  run ranges → pages 20 and 21
- Systematic uncertainties
  - New JES uncertainty: now use curve (function of jet  $P_{\text{T}}$ ) provided by the JER Group → between 2 and 3% instead of the flat 3% used previously: see page 22
  - Justify that the MC reproduce the Missing  $E_{\text{T}}$  scale at least at a  $\pm 10\%$  level → page 23

# Bisector Method: angle $\gamma$

2

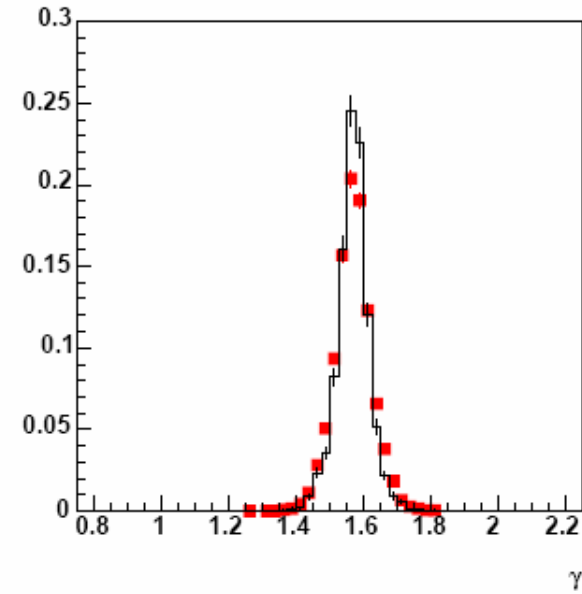
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 1.567  
RMS 0.08962



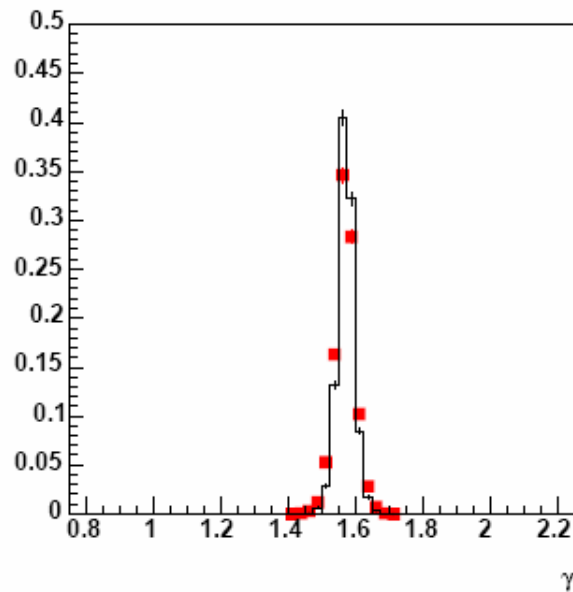
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean 1.569  
RMS 0.05575



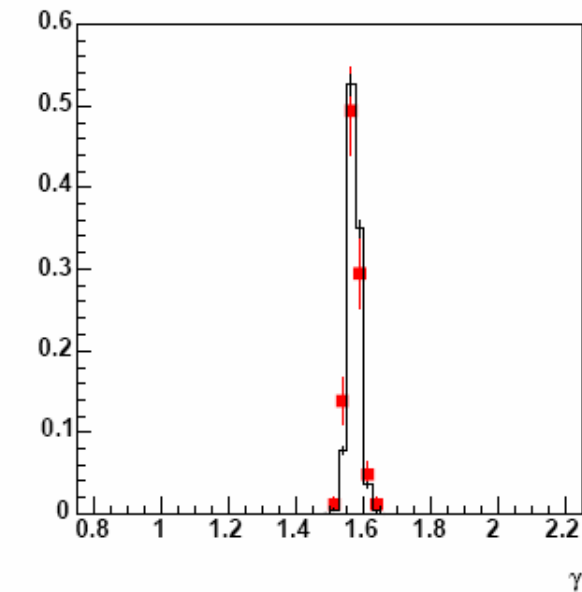
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 1.57  
RMS 0.03135



D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

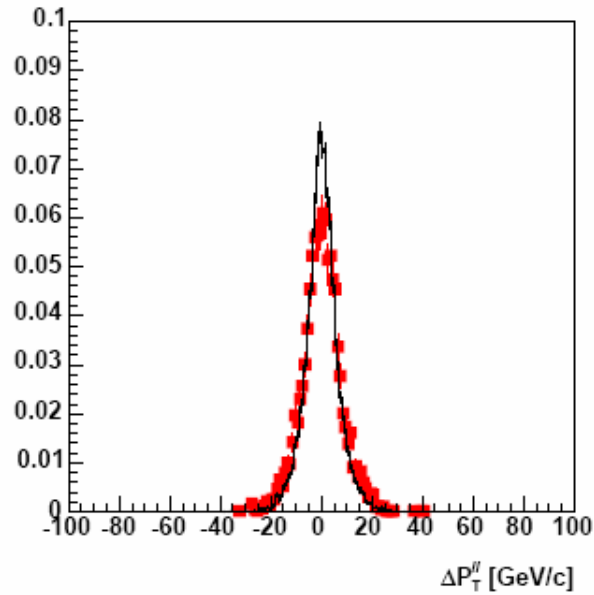
Mean 1.569  
RMS 0.02111



# Bisector Method: $\Delta P_T^{//}$

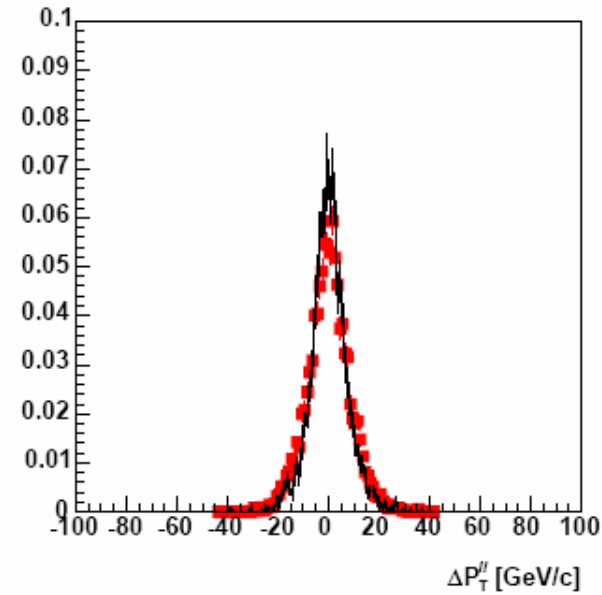
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 0.05127  
RMS 7.757



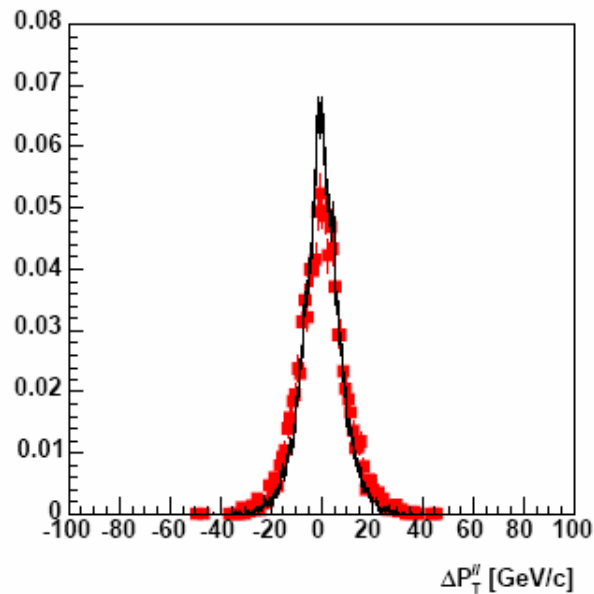
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean 0.000742  
RMS 8.476



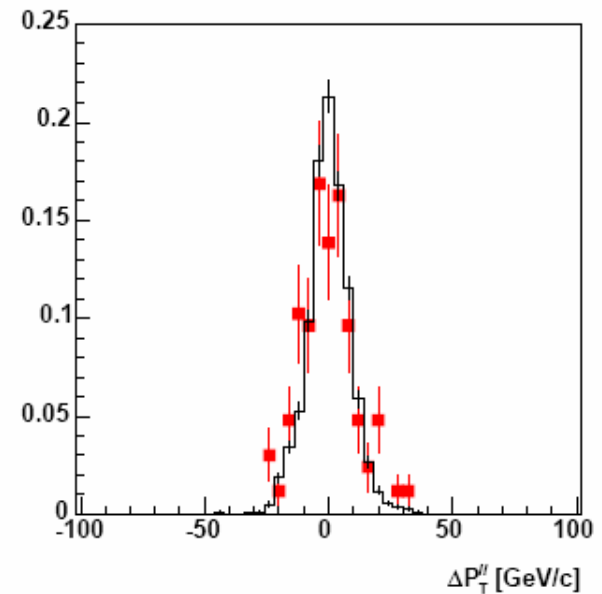
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 0.08741  
RMS 9.487



D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

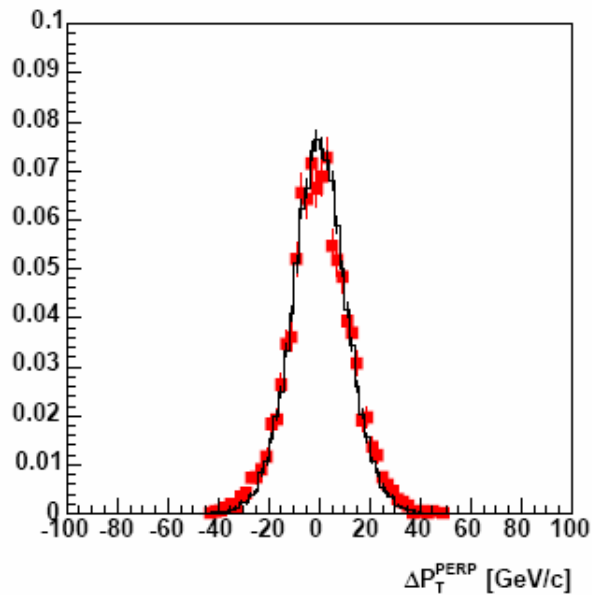
Mean -0.3373  
RMS 11



# Bisector Method: $\Delta P_T^{\text{PERP}}$

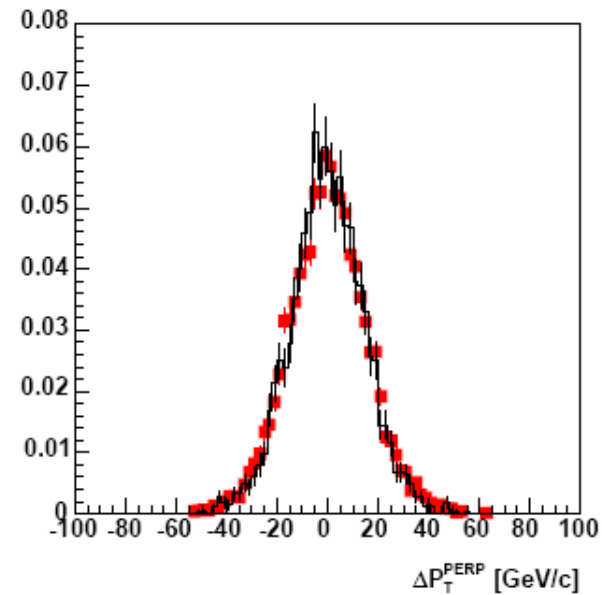
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 0.05736  
RMS 12.21



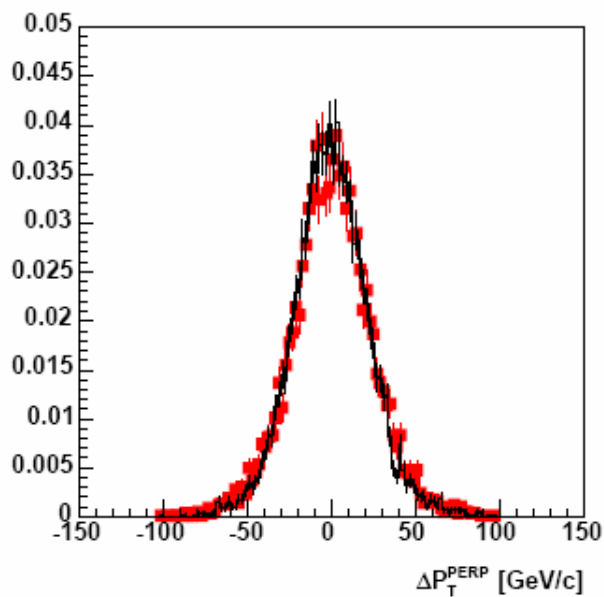
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean -0.008162  
RMS 15.35



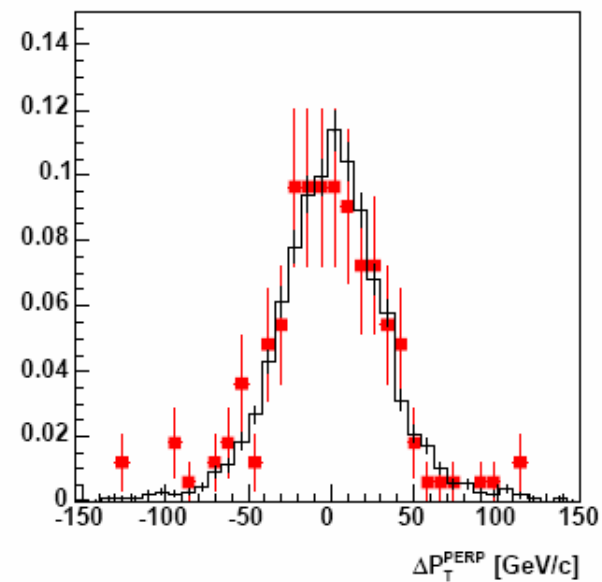
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 0.2915  
RMS 24.07

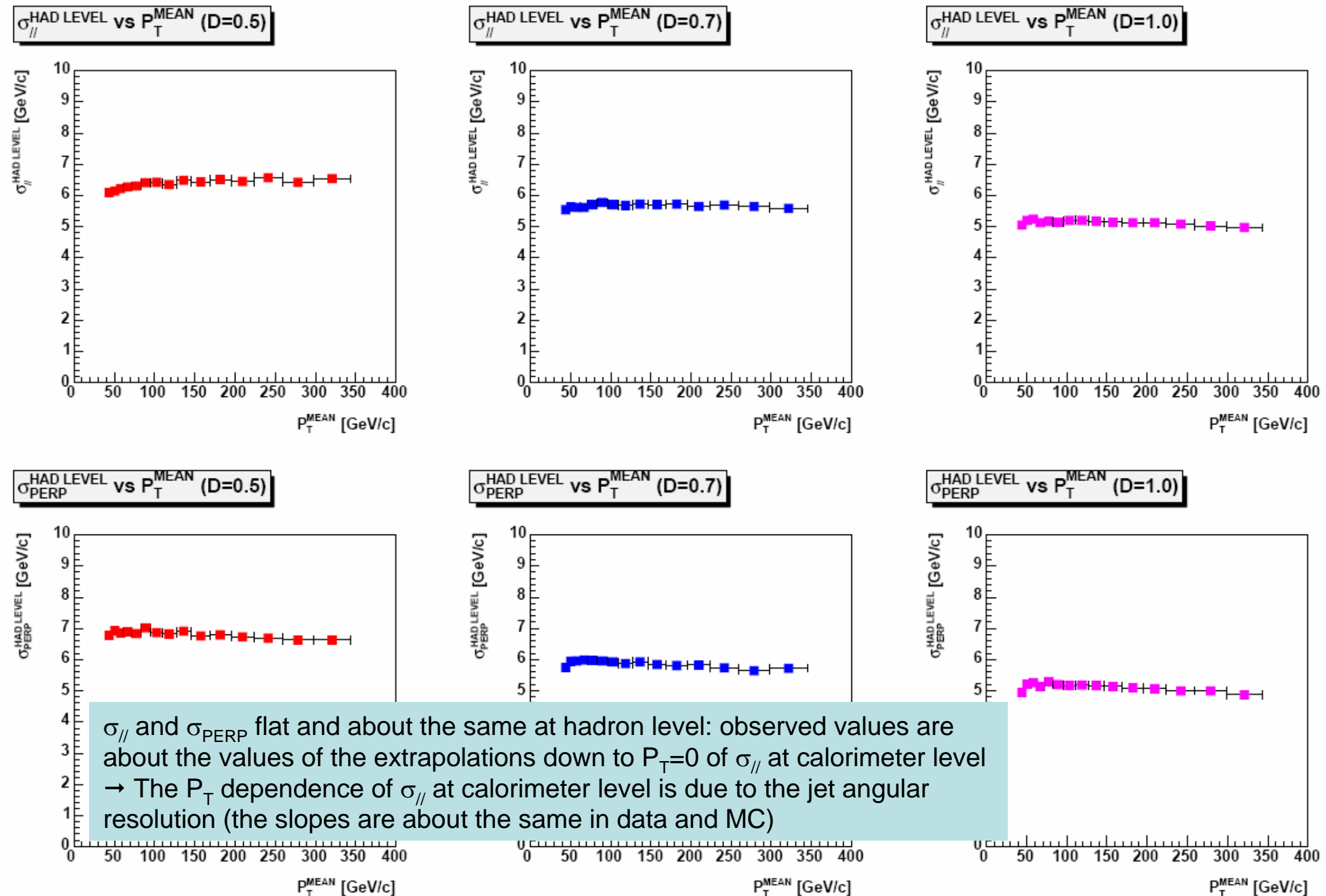


D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean -2.964  
RMS 38.09



# Bisector Method at Hadron Level

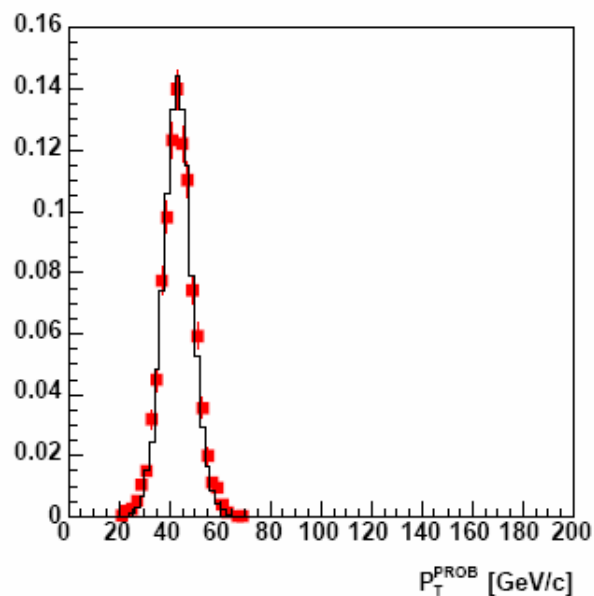


# Dijet Balance: $P_T^{\text{PROB}}$

6

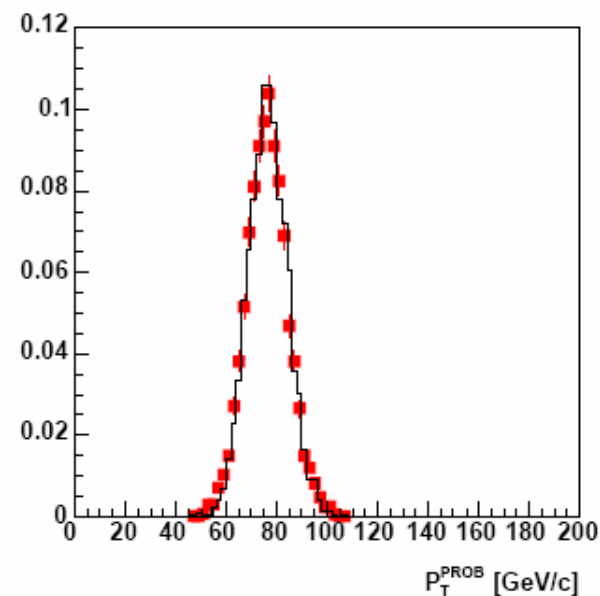
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 43.33  
RMS 6.366



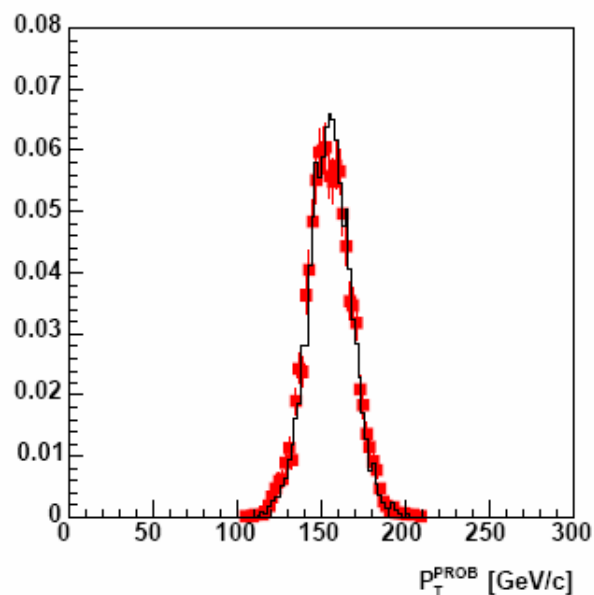
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean 76.08  
RMS 8.228



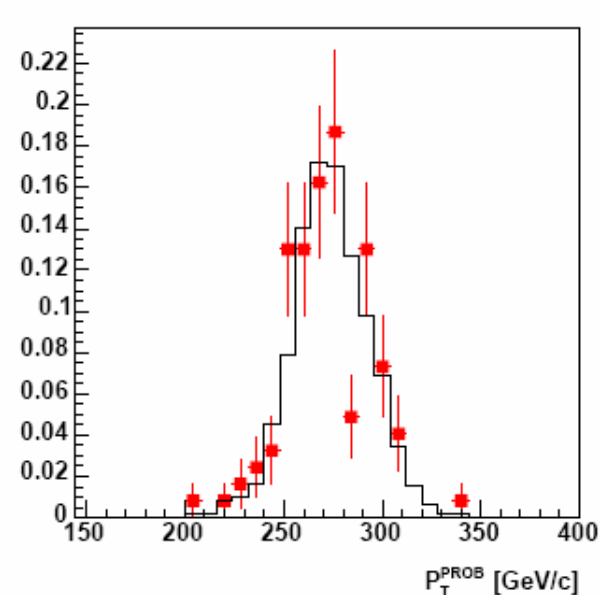
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 154.9  
RMS 13.41



D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean 271.7  
RMS 20.76

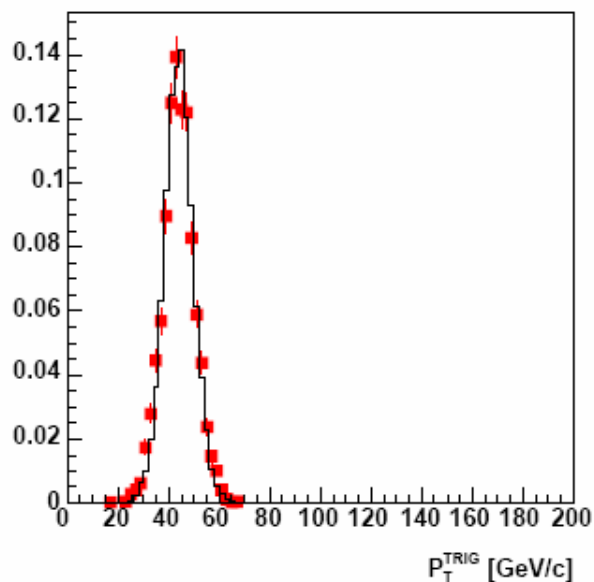


# Dijet Balance: $P_T^{\text{TRIG}}$

7

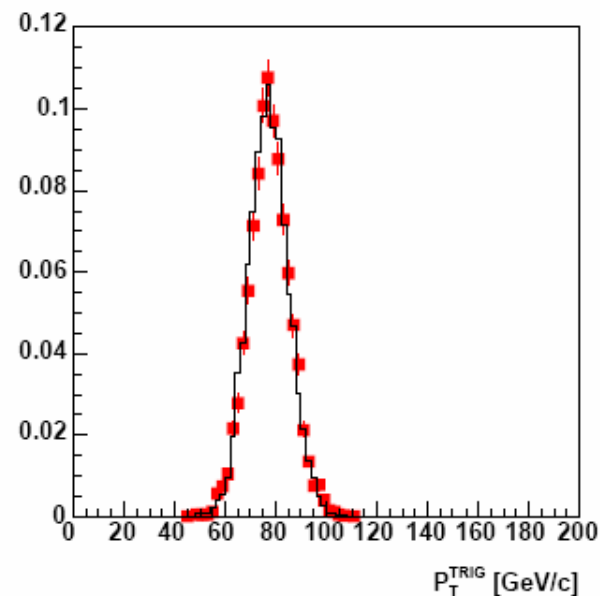
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 43.89  
RMS 6.305



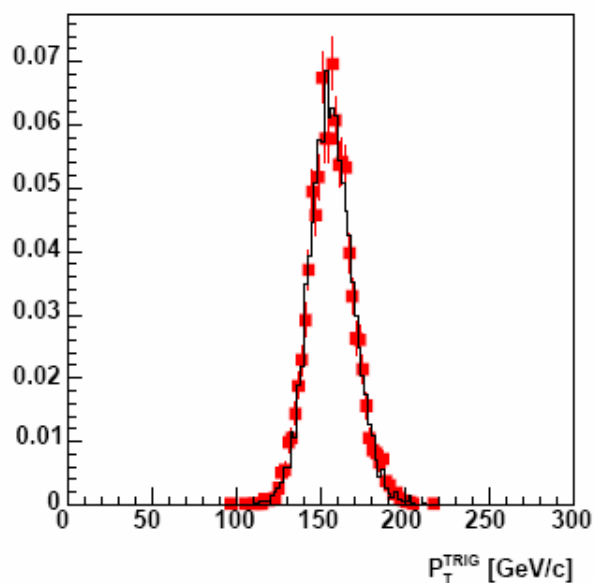
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean 77.42  
RMS 8.167



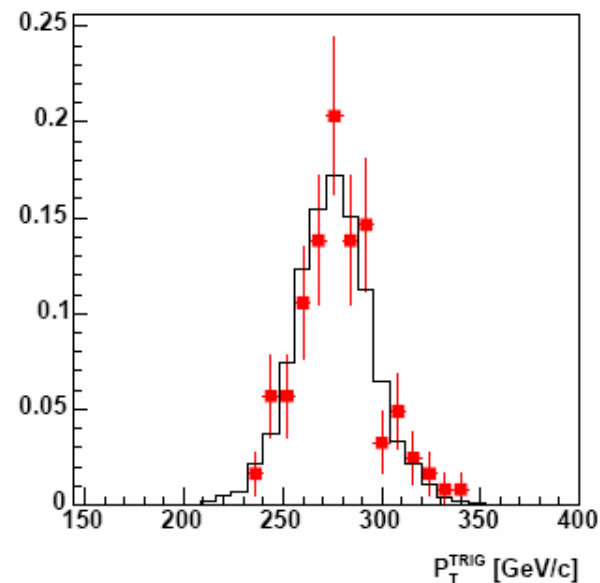
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 156.5  
RMS 13.2



D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean 277.9  
RMS 19.99

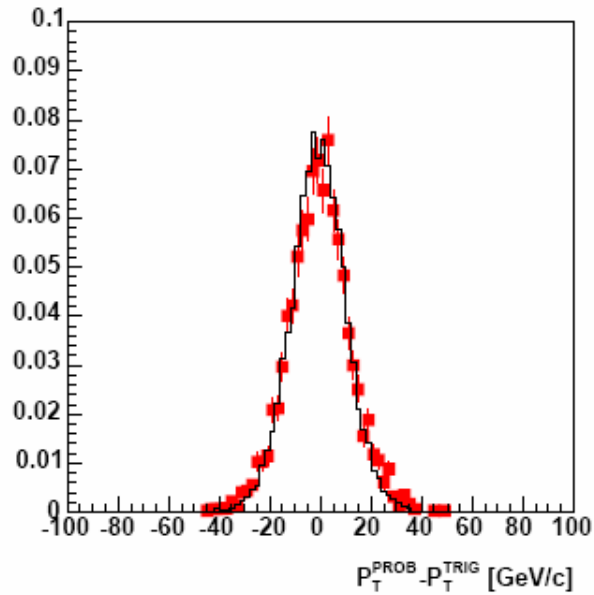


# Dijet Balance: $P_T^{\text{PROB}} - P_T^{\text{TRIG}}$

8

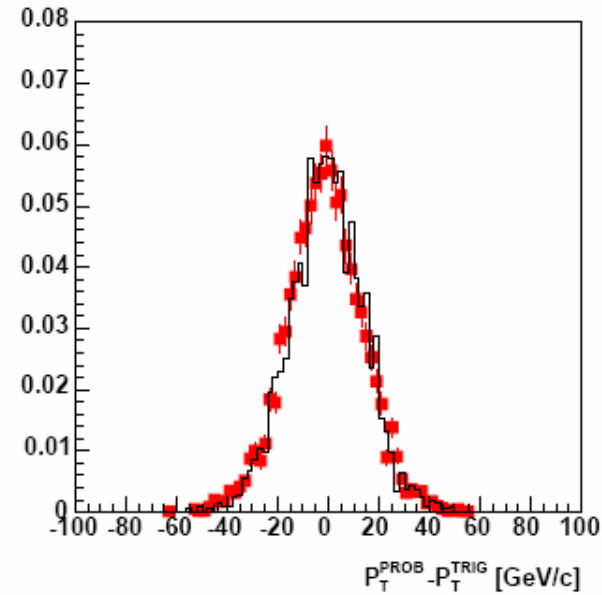
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean -0.5622  
RMS 12.16



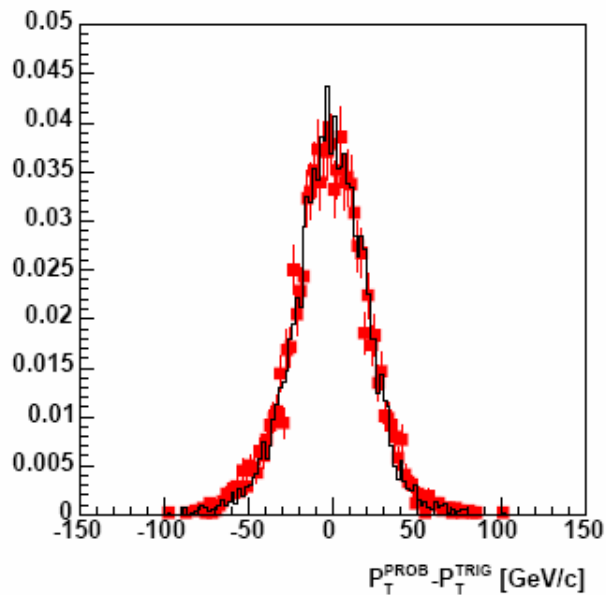
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean -1.346  
RMS 15.11



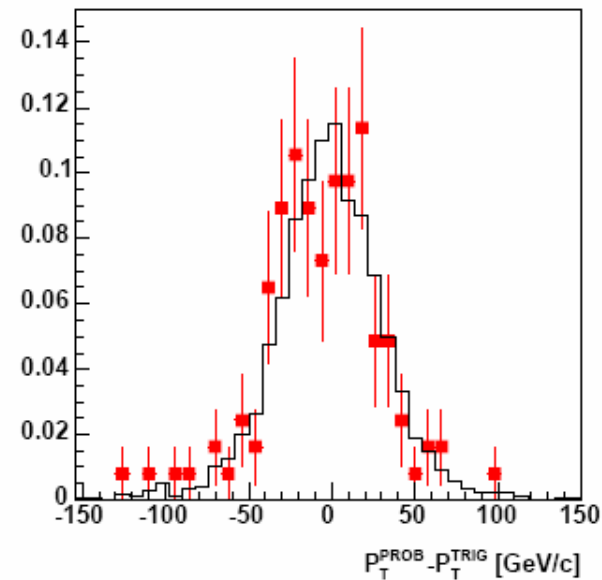
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean -1.61  
RMS 23.17



D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean -5.87  
RMS 34.5

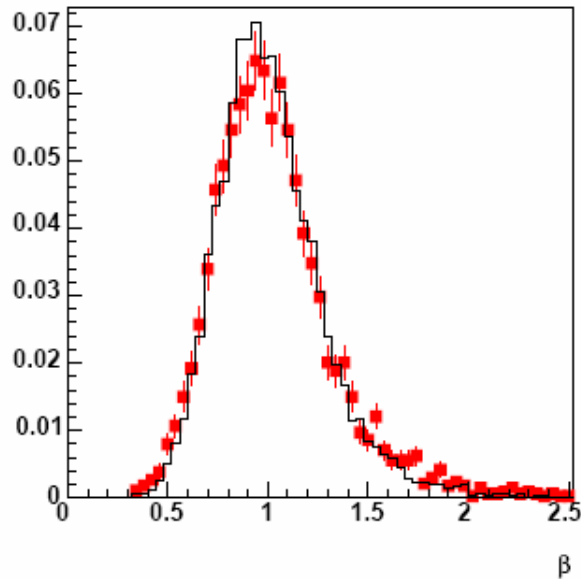




# Dijet Balance: $\beta$ distribution

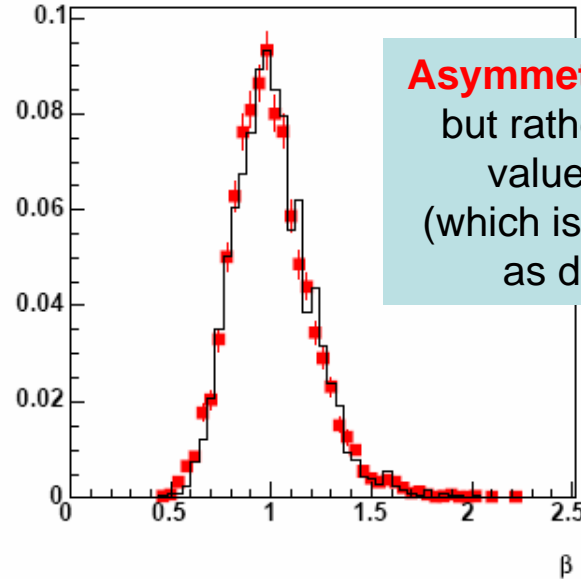
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 1.026  
RMS 0.299



D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

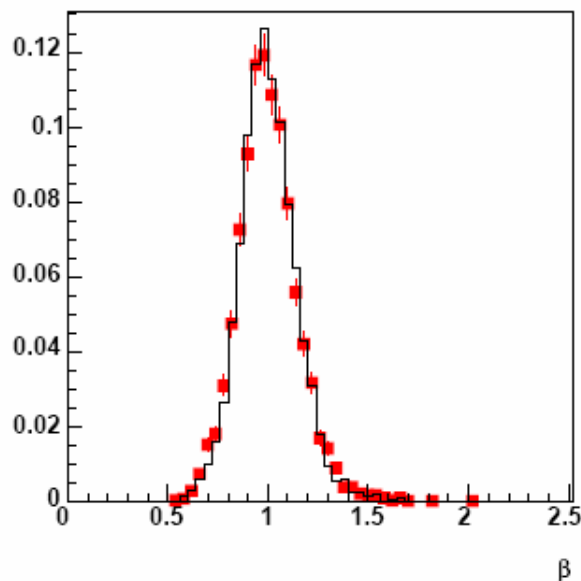
Mean 1.002  
RMS 0.2026



**Asymmetric tail** → we don't use that but rather define  $\beta$  from the mean value of the  $\Delta P_T^F$  distribution (which is symmetric, see next slide) as done by the JER Group

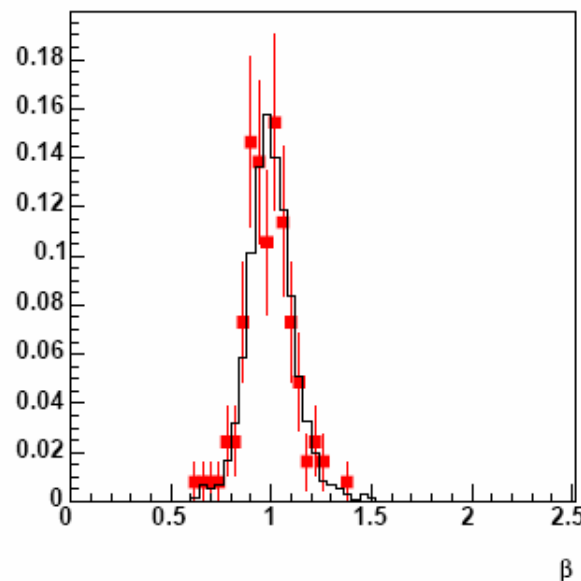
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 1.001  
RMS 0.1506



D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

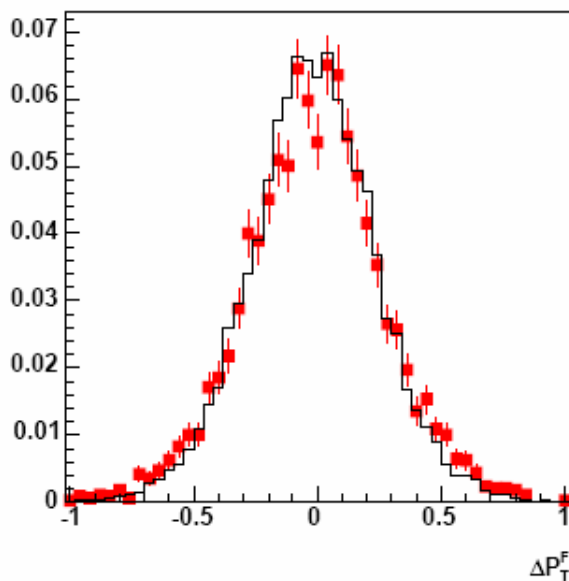
Mean 0.9842  
RMS 0.1212



# Dijet Balance: $\Delta P_T^F$

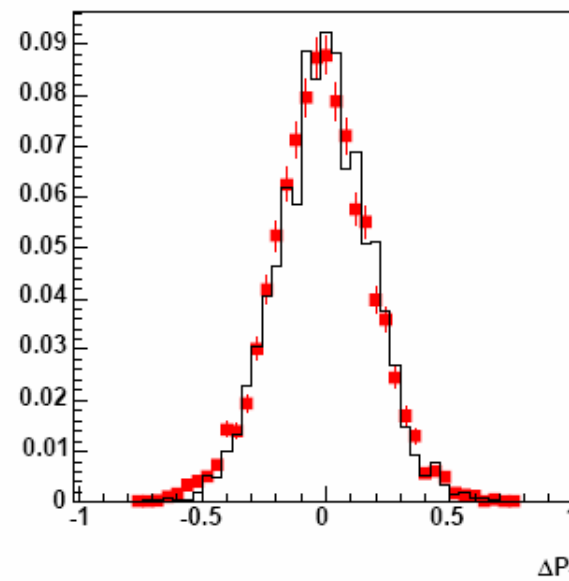
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean-0.01372  
RMS 0.278



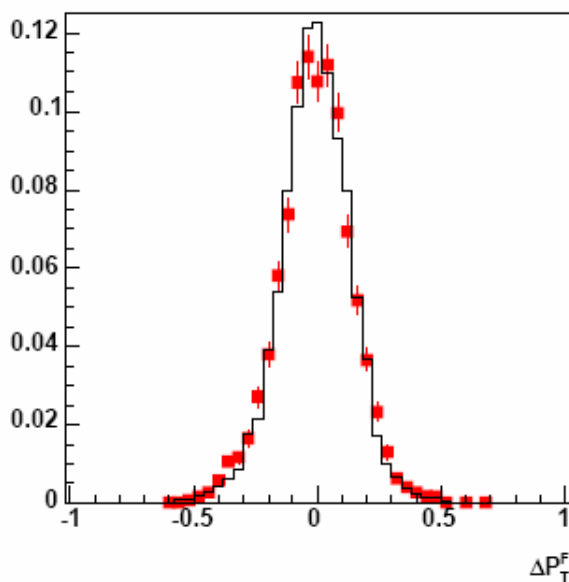
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean-0.01744  
RMS 0.1974



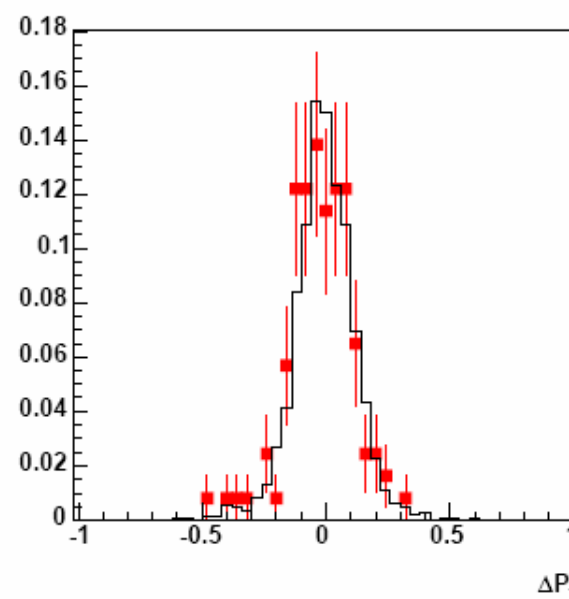
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean-0.01036  
RMS 0.1488

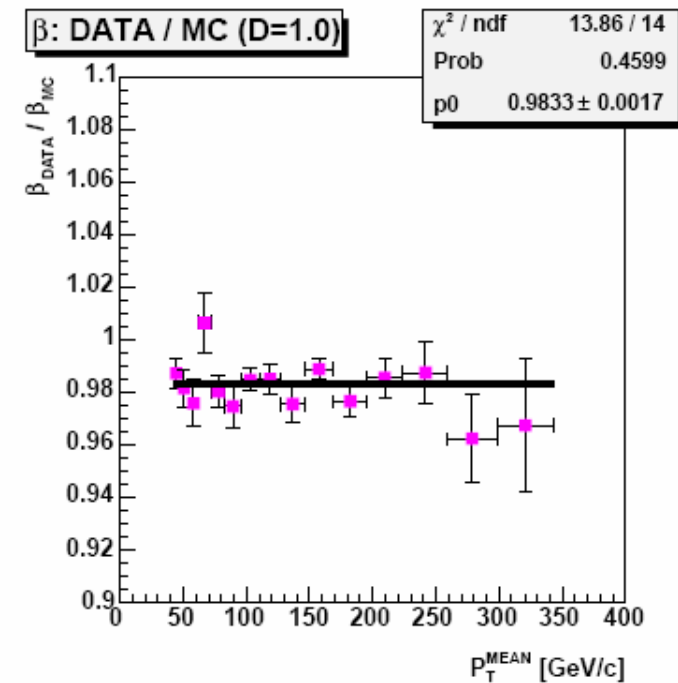
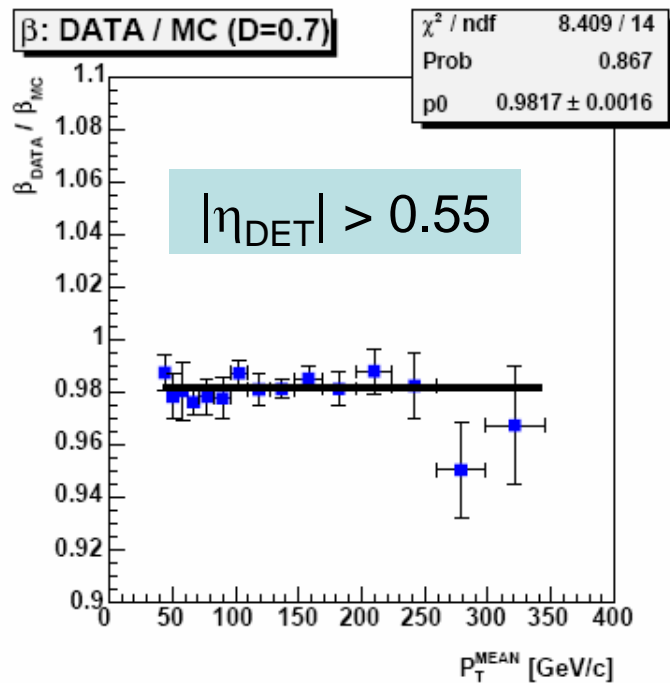
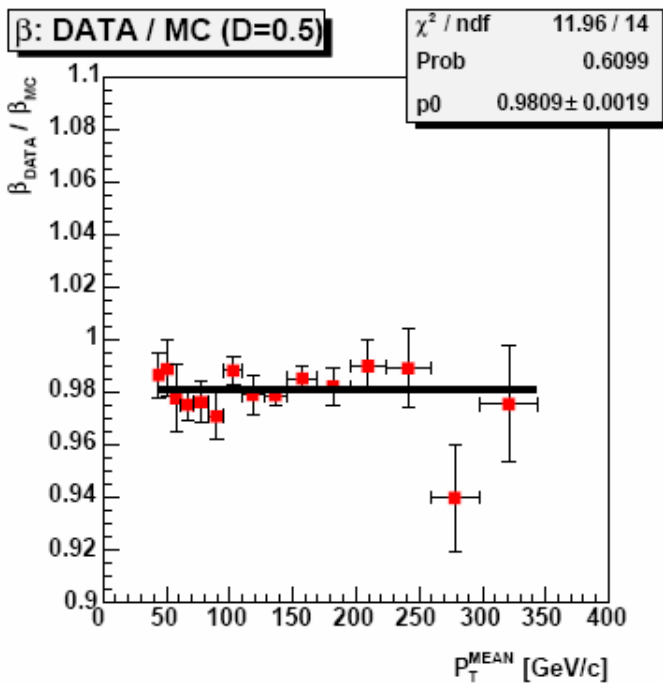
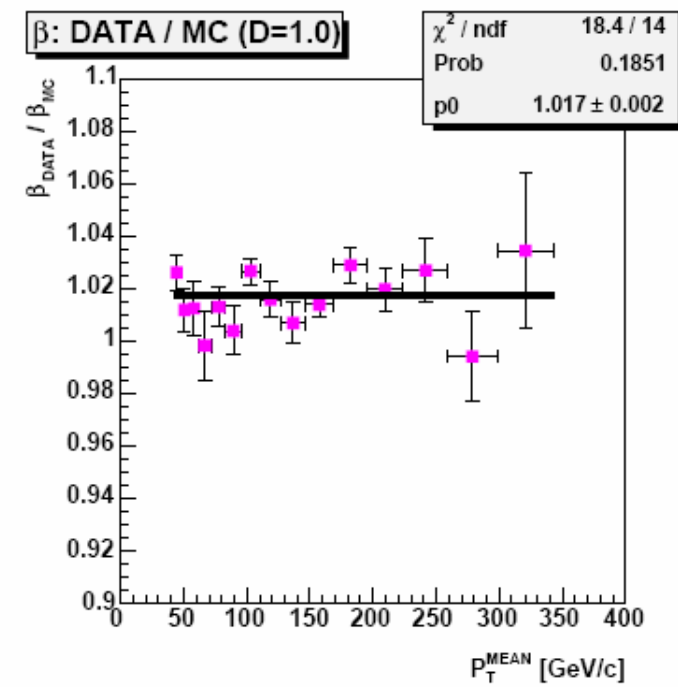
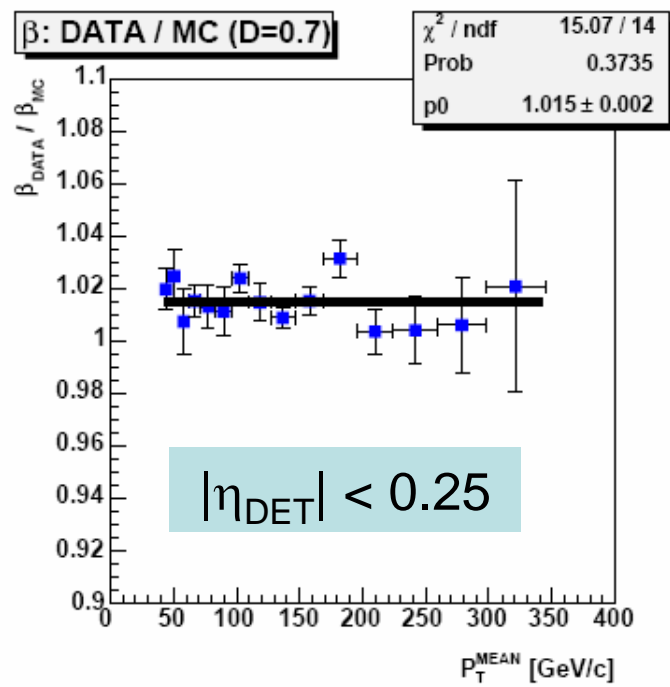
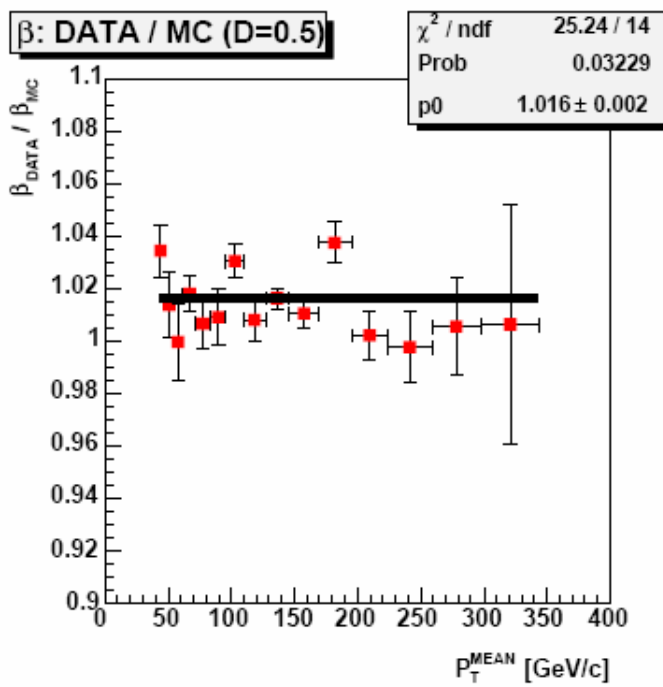


D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

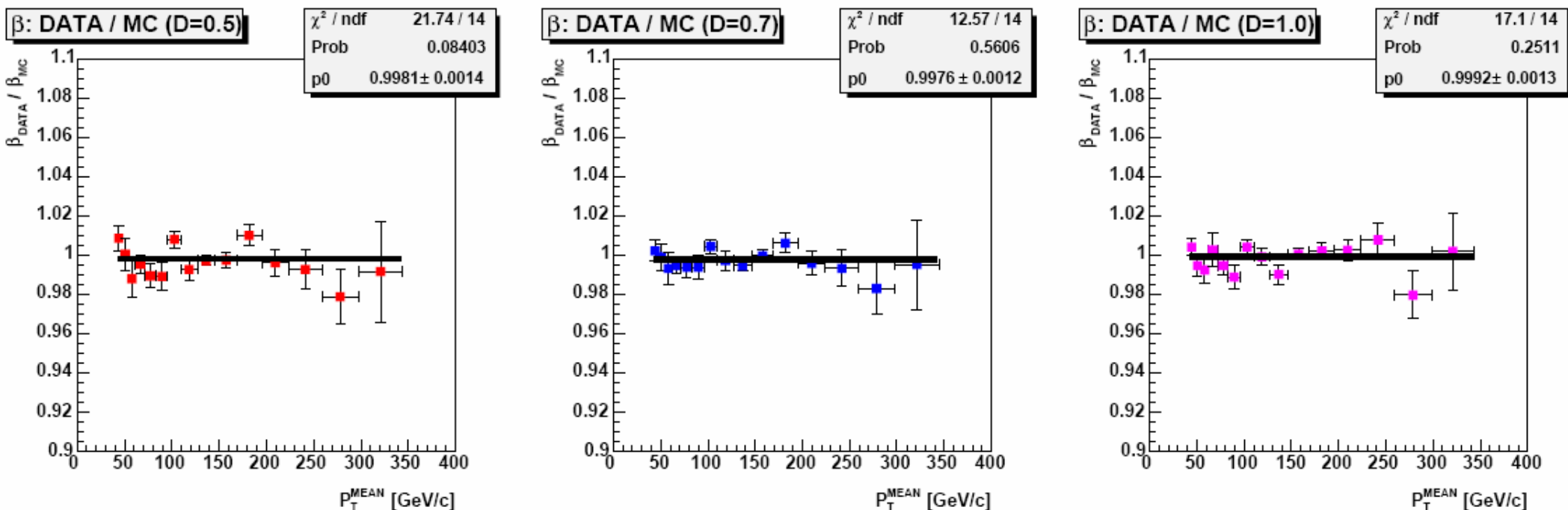
Mean-0.02146  
RMS 0.1258



# Dijet Balance: Probe Jet / $|\eta_{\text{DET}}| < 0.25$ ( $> 0.55$ ) <sup>11</sup>



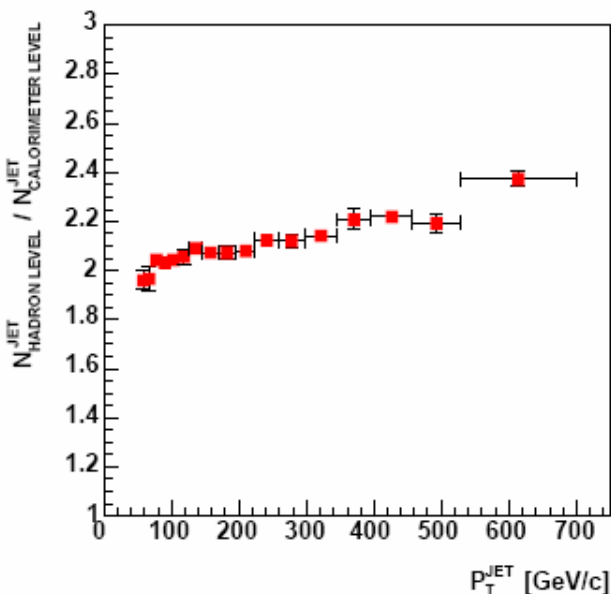
# Dijet Balance: Probe Jet / $|\eta_{\text{DET}}| \notin [0.25, 0.55]$ 12



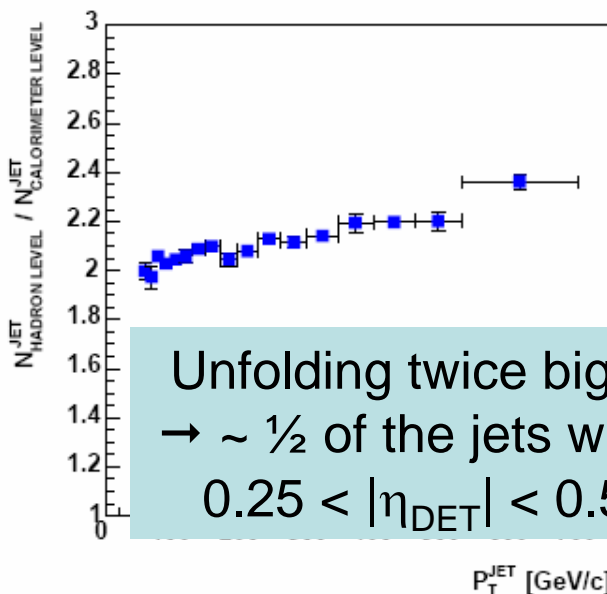
- $|\eta_{\text{DET}}| < 0.25$  ( $> 0.55$ )
  - Discrepancies between Data and MC are within the JES uncertainty
    - Discrepancies in opposite directions for  $|\eta_{\text{DET}}| < 0.25$  and  $|\eta_{\text{DET}}| > 0.55$
    - Explain discrepancy between data and MC concerning the rapidity distributions
- Probe jet /  $0.1 < |Y| < 0.7$  &&  $|\eta_{\text{DET}}| \notin [0.25, 0.55]$ 
  - Dijet Balance is globally OK
    - Discrepancies between Data and MC for  $|\eta_{\text{DET}}| < 0.25$  on one hand and  $|\eta_{\text{DET}}| > 0.55$  on the other hand compensate here
    - What happens for the cross section: see next slide...

# Unfolded $\sigma \rightarrow 0.1 < |Y^{\text{CAL}}| < 0.7$ vs $0.25 < |\eta_{\text{DET}}^{(\text{CAL})}| < 0.55$ <sup>13</sup>

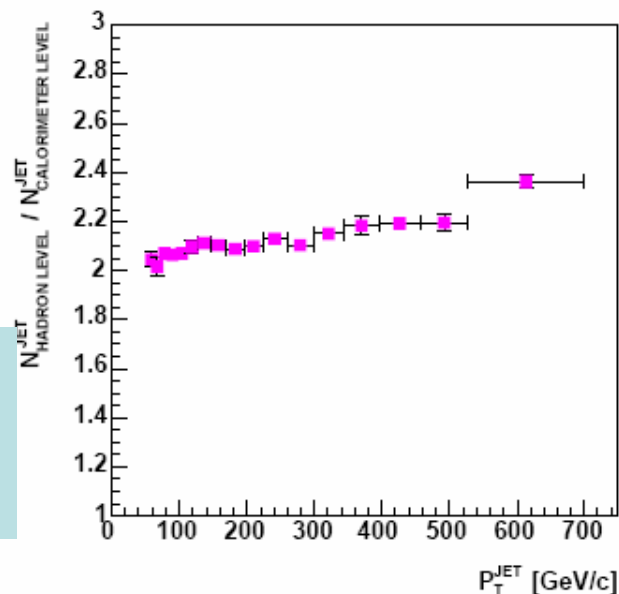
Unfolding requiring  $0.25 < |\eta_{\text{DET}}^{\text{CAL}}| < 0.55$  (D=0.5)



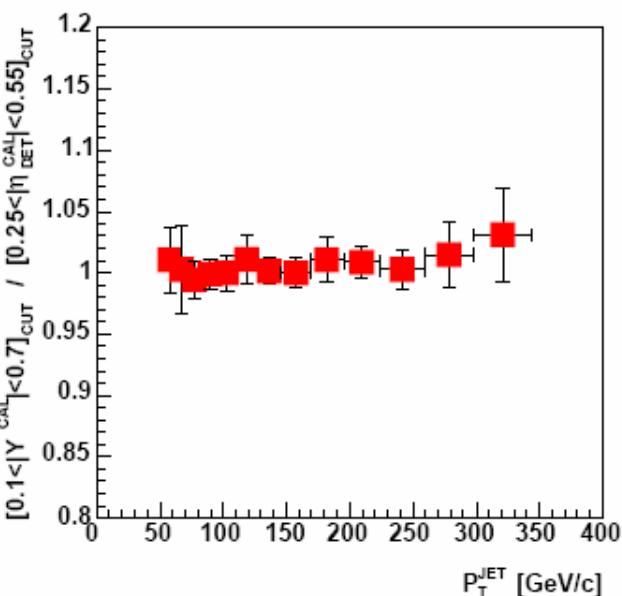
Unfolding requiring  $0.25 < |\eta_{\text{DET}}^{\text{CAL}}| < 0.55$  (D=0.7)



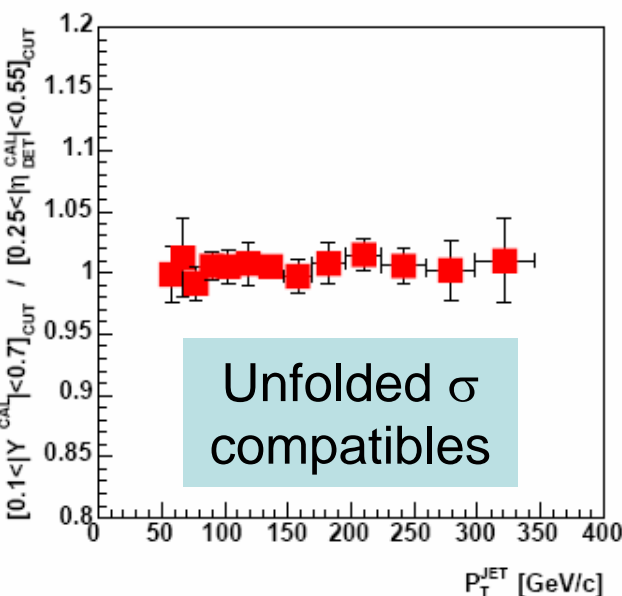
Unfolding requiring  $0.25 < |\eta_{\text{DET}}^{\text{CAL}}| < 0.55$  (D=1.0)



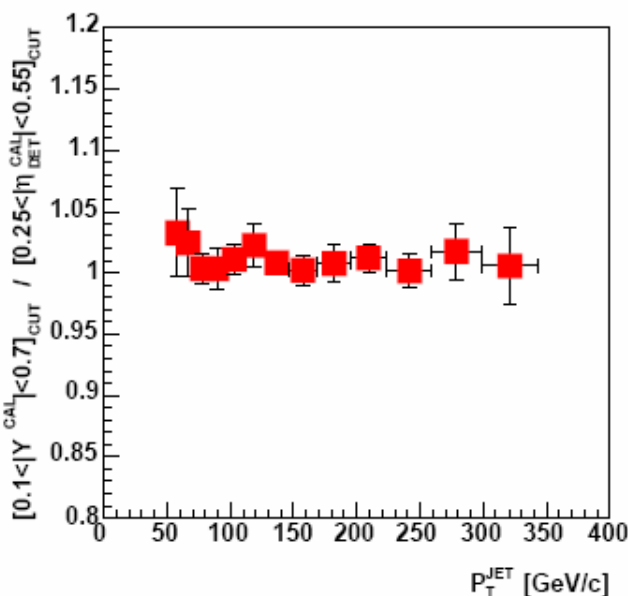
$N_{\text{DATA}}^{\text{JET}}$  ratio after unfolding (D=0.5)



$N_{\text{DATA}}^{\text{JET}}$  ratio after unfolding (D=0.7)



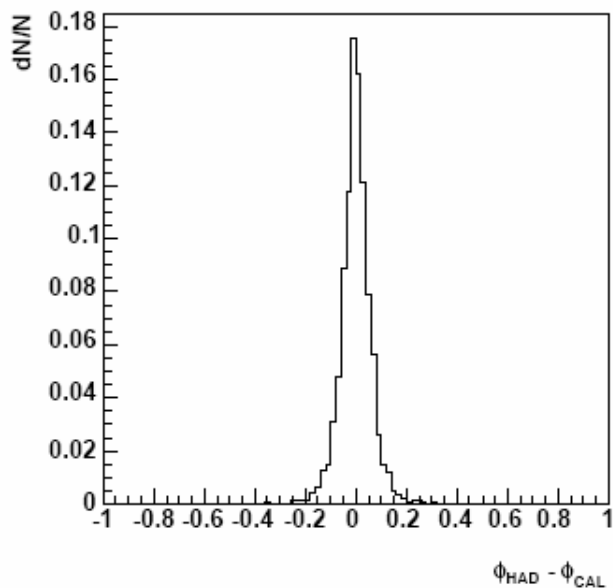
$N_{\text{DATA}}^{\text{JET}}$  ratio after unfolding (D=1.0)



# CAL / HAD matching: $\Delta\phi$

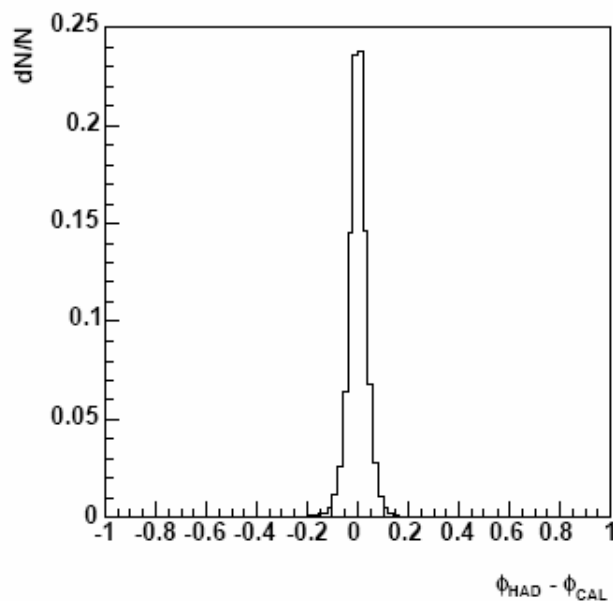
D=0.5:  $23 < P_T^{\text{MEAN}} < 27 \text{ GeV/c}$

Mean -0.000462  
RMS 0.06441



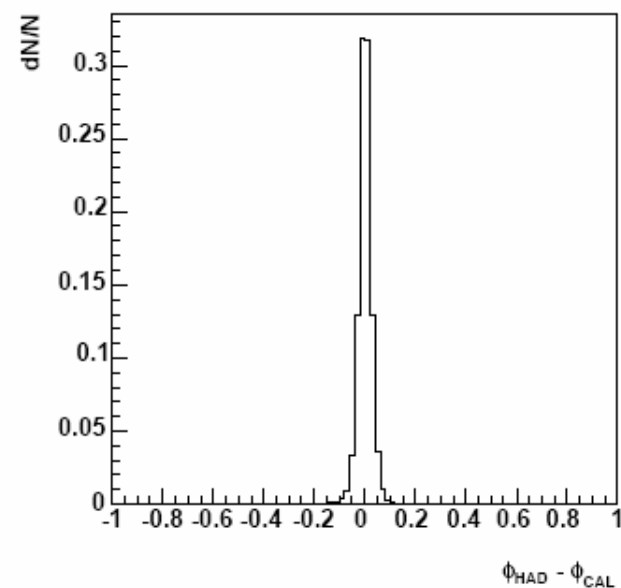
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 0.000161  
RMS 0.04389



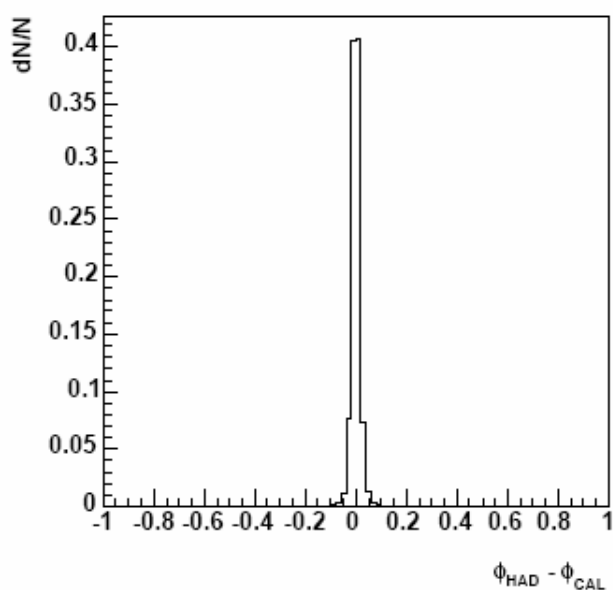
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean -5.206e-05  
RMS 0.03178



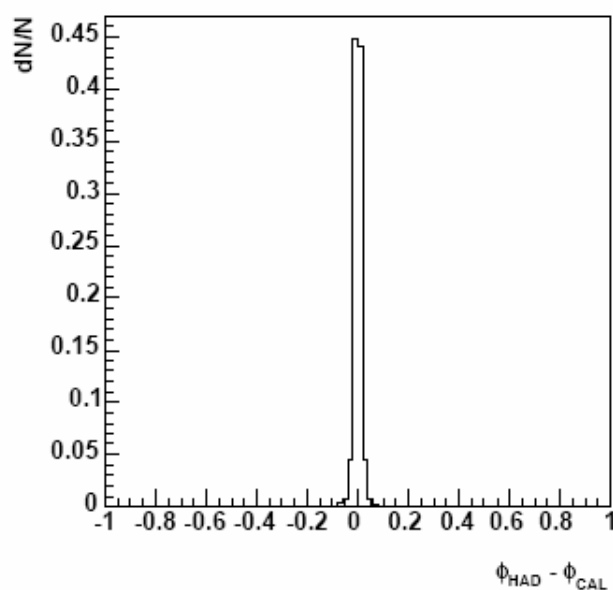
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 2.608e-05  
RMS 0.02172



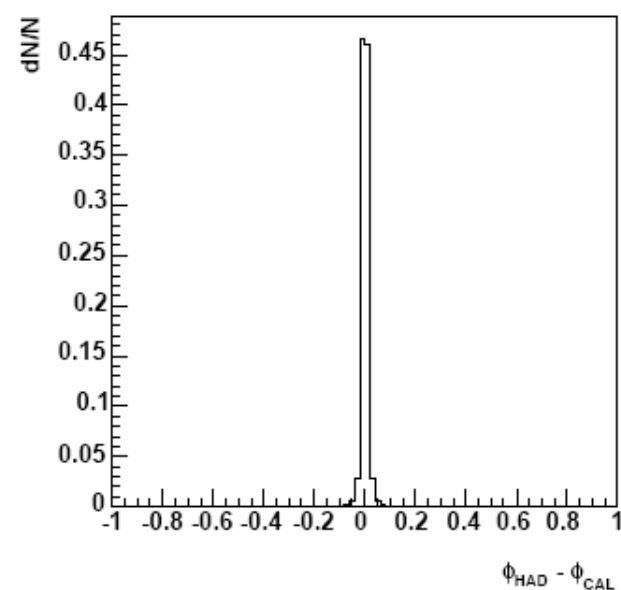
D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean -0.0001432  
RMS 0.01677



D=0.5:  $527 < P_T^{\text{MEAN}} < 700 \text{ GeV/c}$

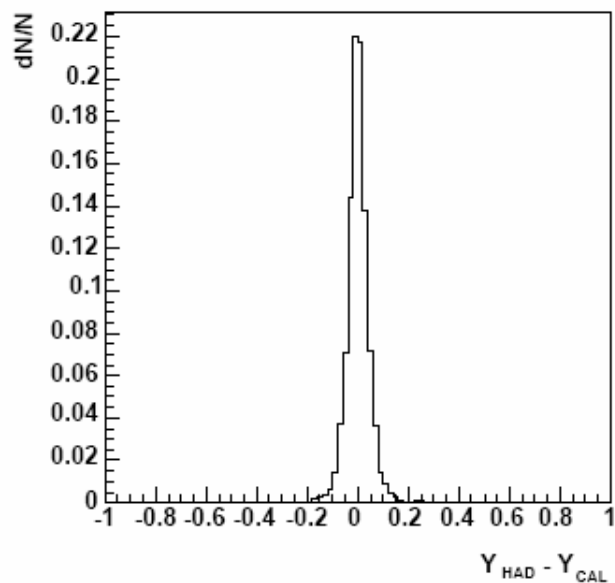
Mean -2.412e-05  
RMS 0.01506



# CAL / HAD matching: $\Delta Y$

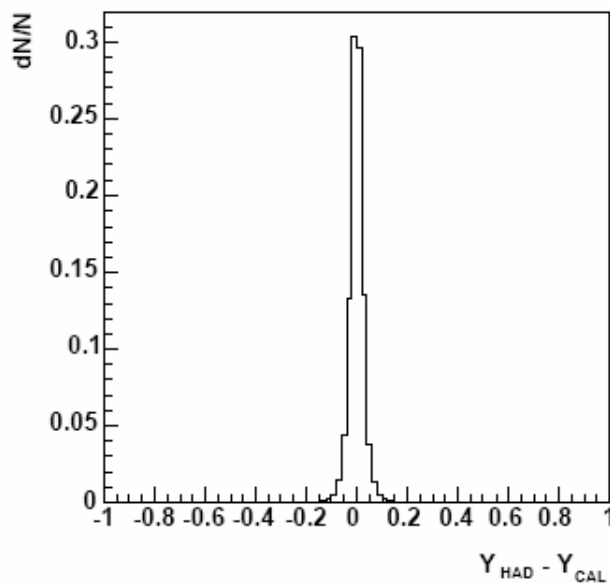
D=0.5:  $23 < P_T^{\text{MEAN}} < 27 \text{ GeV/c}$

Mean 0.0003202  
RMS 0.04538



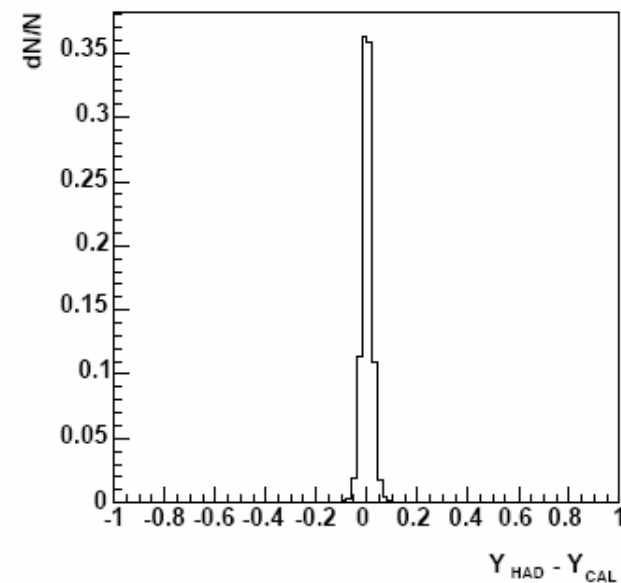
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean -0.0002316  
RMS 0.03312



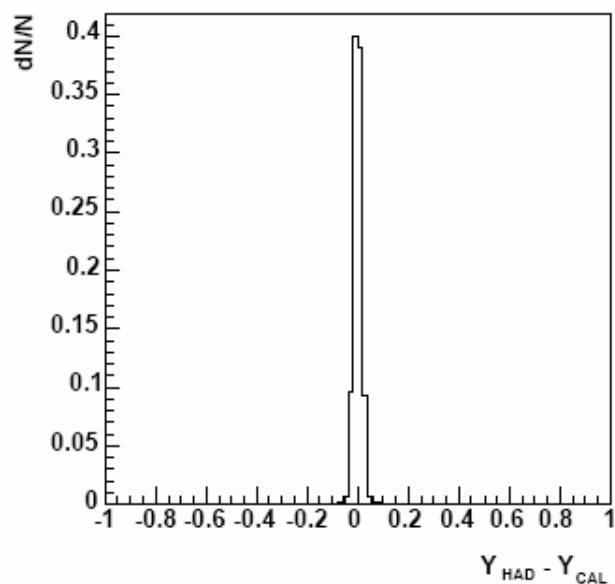
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean -0.0002048  
RMS 0.02508



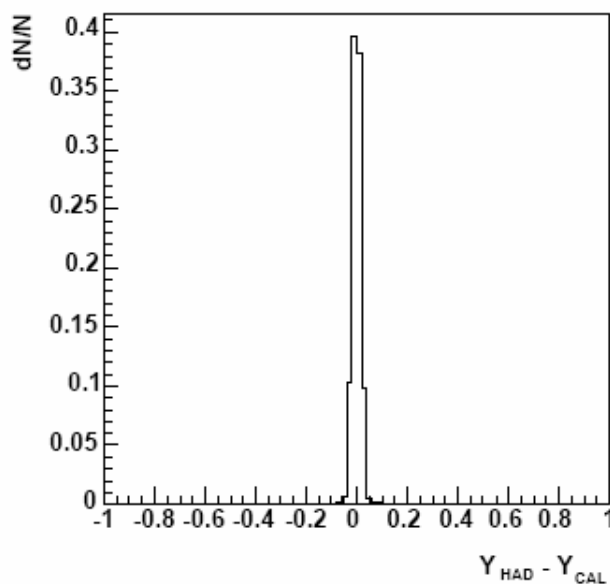
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean -0.0001933  
RMS 0.01978



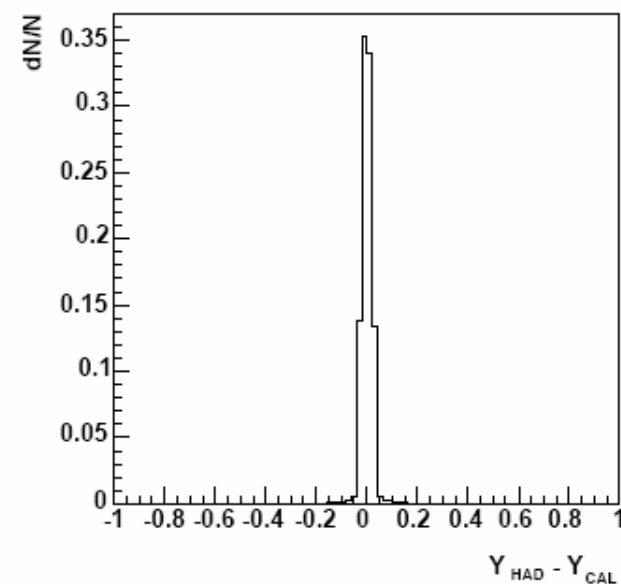
D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean -0.0003582  
RMS 0.02101



D=0.5:  $527 < P_T^{\text{MEAN}} < 700 \text{ GeV/c}$

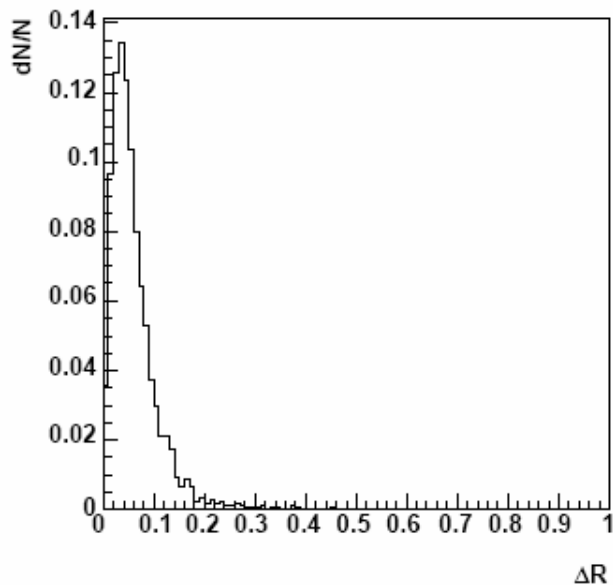
Mean -0.0002389  
RMS 0.02772



# CAL / HAD matching: $\Delta R$

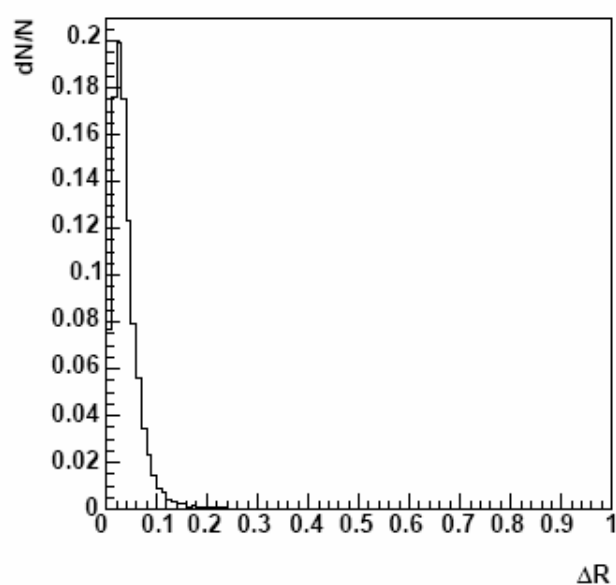
D=0.5:  $23 < P_T^{\text{MEAN}} < 27 \text{ GeV/c}$

Mean 0.061  
RMS 0.04929



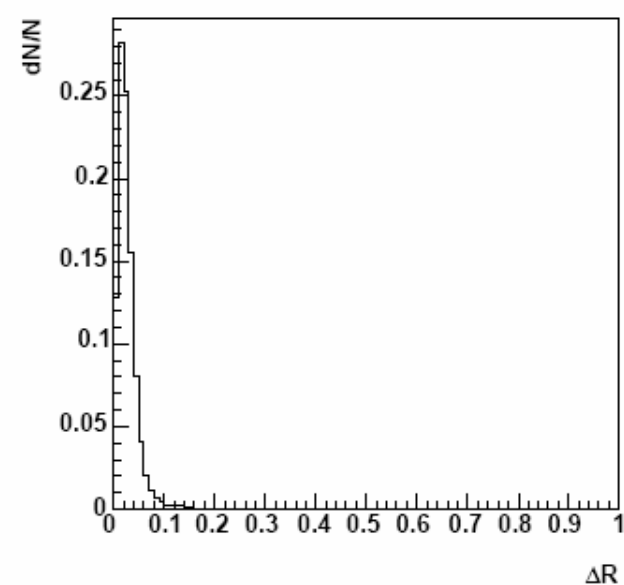
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 0.04029  
RMS 0.03657



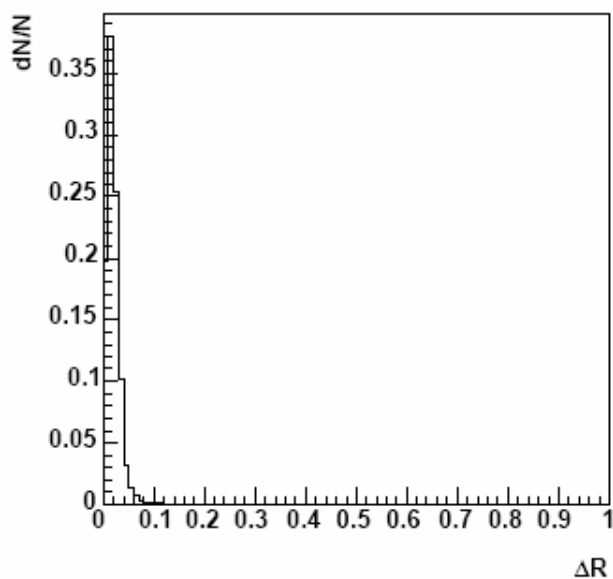
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean 0.02859  
RMS 0.02763



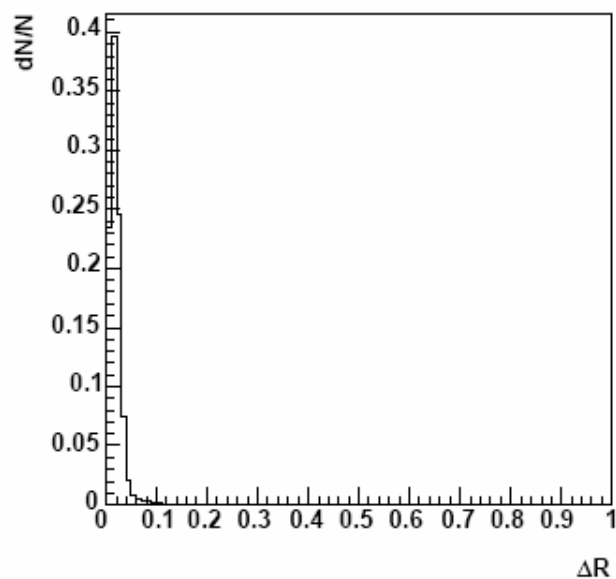
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 0.02102  
RMS 0.01907



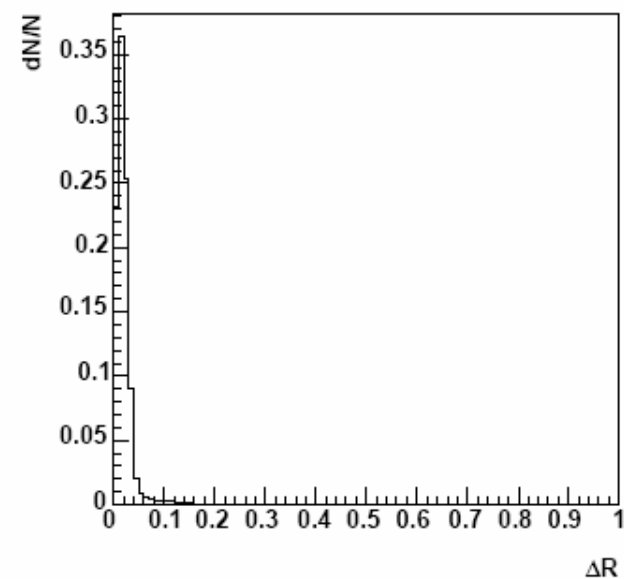
D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean 0.01926  
RMS 0.01689



D=0.5:  $527 < P_T^{\text{MEAN}} < 700 \text{ GeV/c}$

Mean 0.02108  
RMS 0.02167



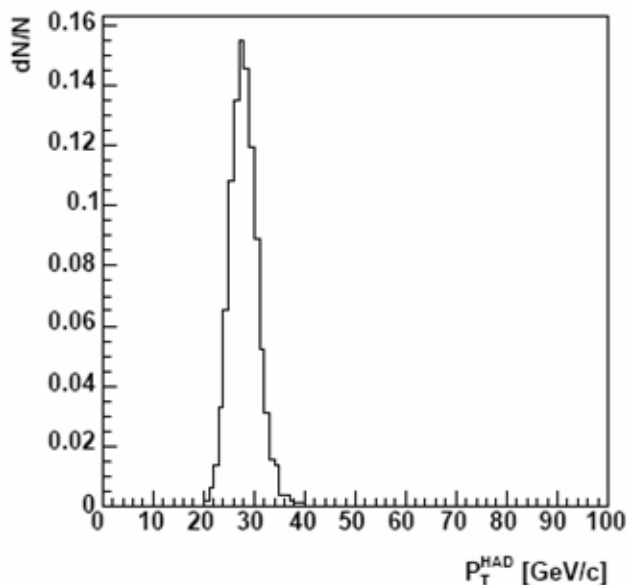


# Absolute $P_T$ jet correction: $P_T^{\text{HAD}}$

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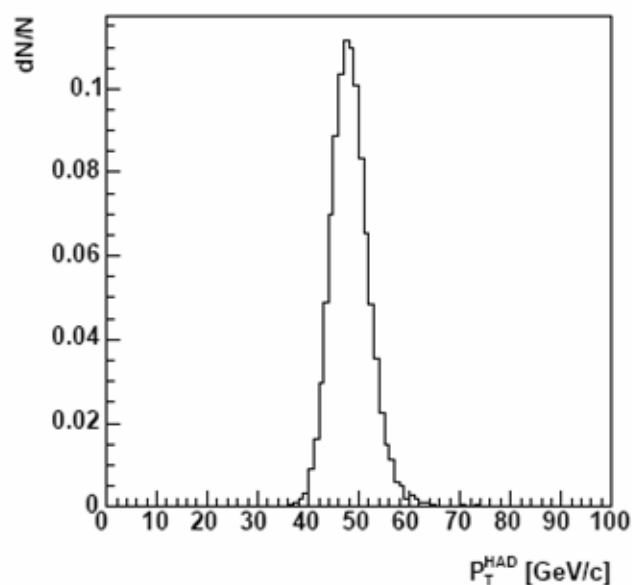
D=0.5:  $23 < P_T^{\text{MEAN}} < 27 \text{ GeV/c}$

Mean 28.02  
RMS 2.768



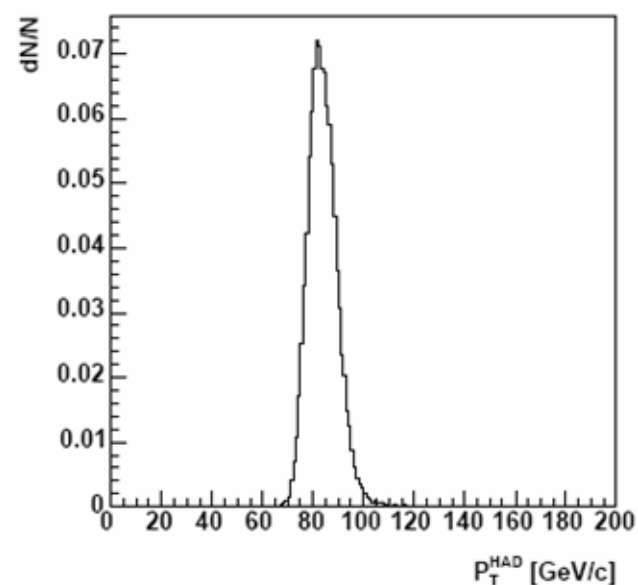
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 48.4  
RMS 4.005



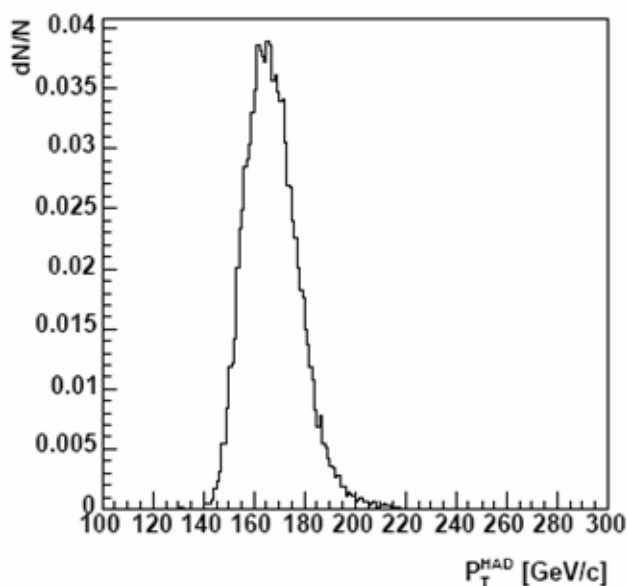
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean 83.94  
RMS 6.115



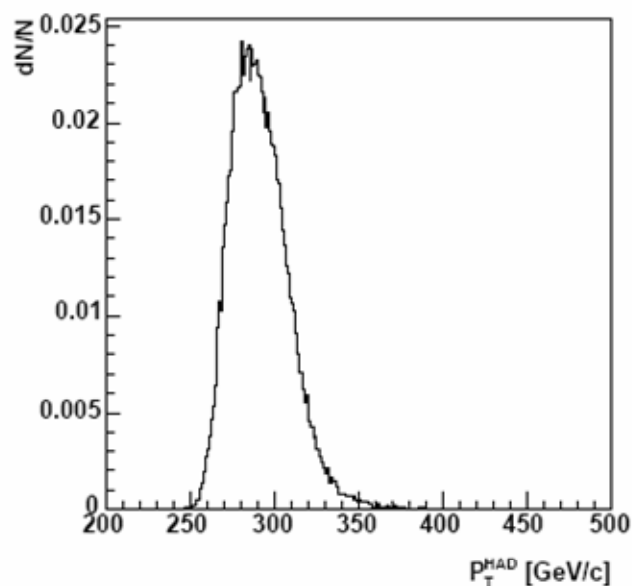
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 167.4  
RMS 10.99



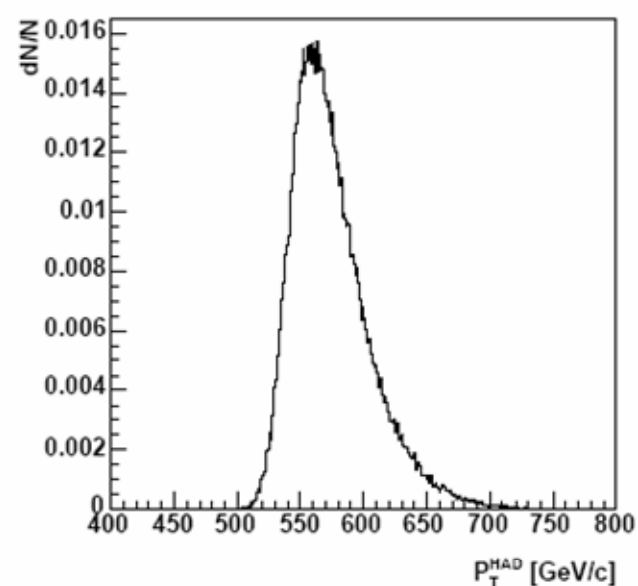
D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean 291.5  
RMS 17.55

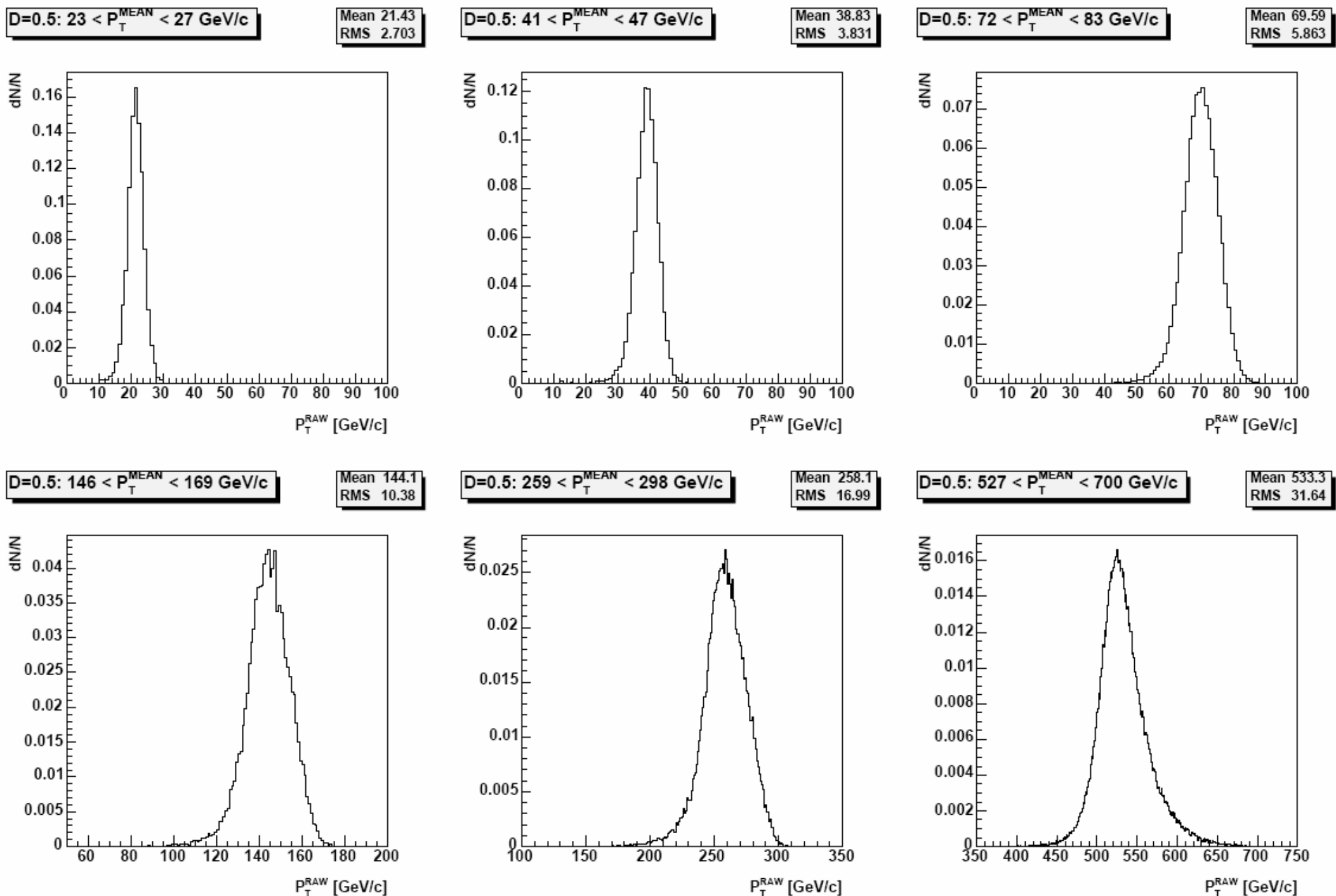


D=0.5:  $527 < P_T^{\text{MEAN}} < 700 \text{ GeV/c}$

Mean 574.5  
RMS 31.1



# Absolute $P_T$ jet correction: $P_T^{\text{RAW}}$

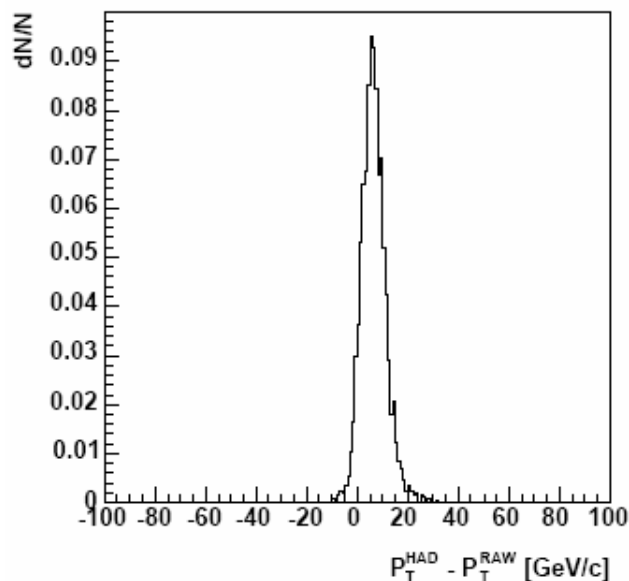


# Absolute $P_T$ jet correction: $P_T^{\text{HAD}} - P_T^{\text{RAW}}$

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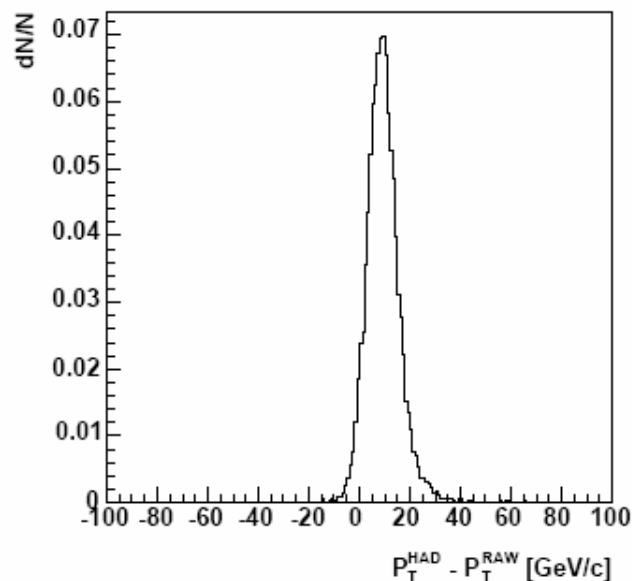
D=0.5:  $23 < P_T^{\text{MEAN}} < 27 \text{ GeV/c}$

Mean 6.584  
RMS 4.949



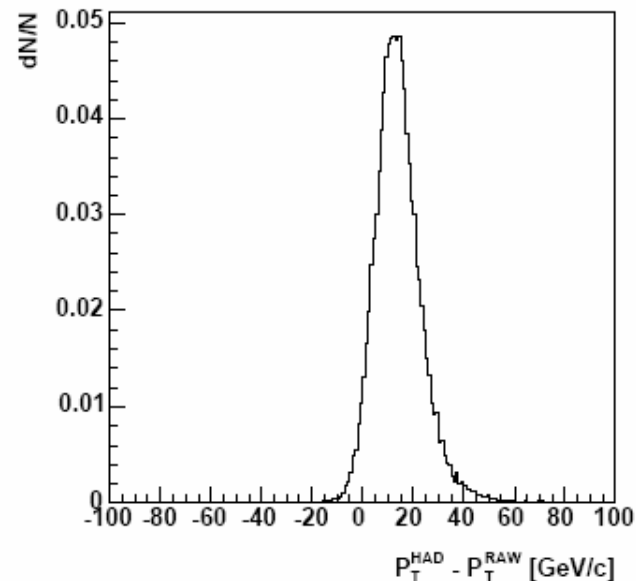
D=0.5:  $41 < P_T^{\text{MEAN}} < 47 \text{ GeV/c}$

Mean 9.571  
RMS 7.034



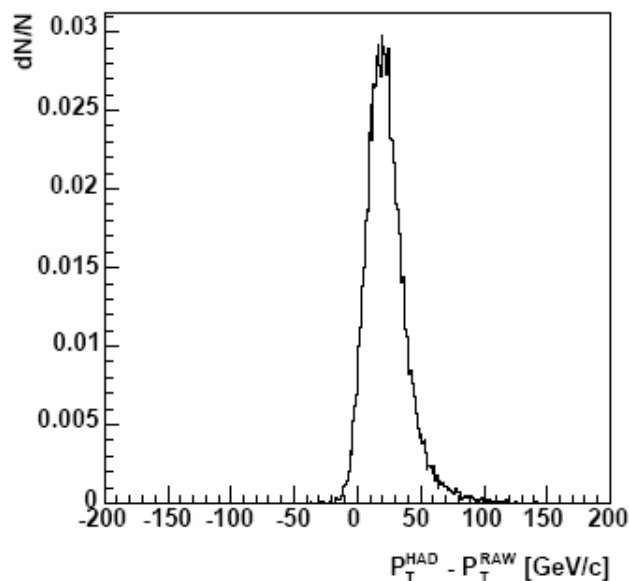
D=0.5:  $72 < P_T^{\text{MEAN}} < 83 \text{ GeV/c}$

Mean 14.26  
RMS 9.698



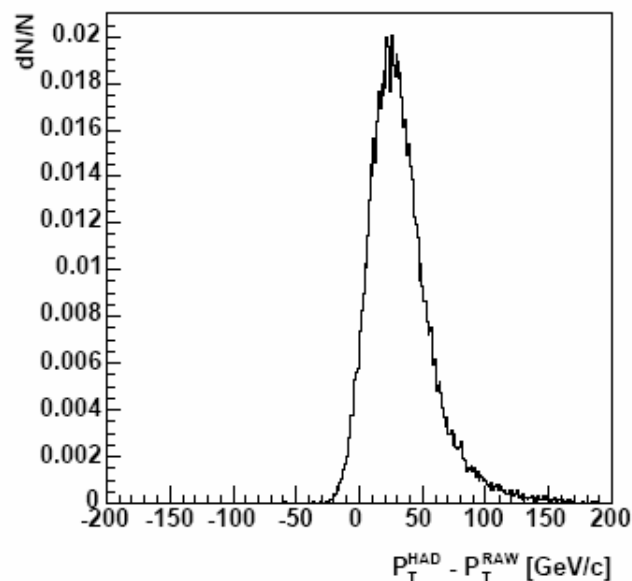
D=0.5:  $146 < P_T^{\text{MEAN}} < 169 \text{ GeV/c}$

Mean 23.31  
RMS 16.68



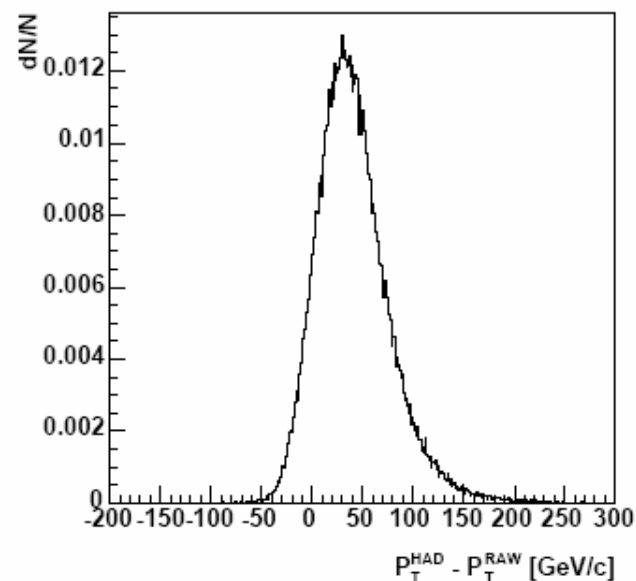
D=0.5:  $259 < P_T^{\text{MEAN}} < 298 \text{ GeV/c}$

Mean 33.24  
RMS 26.41



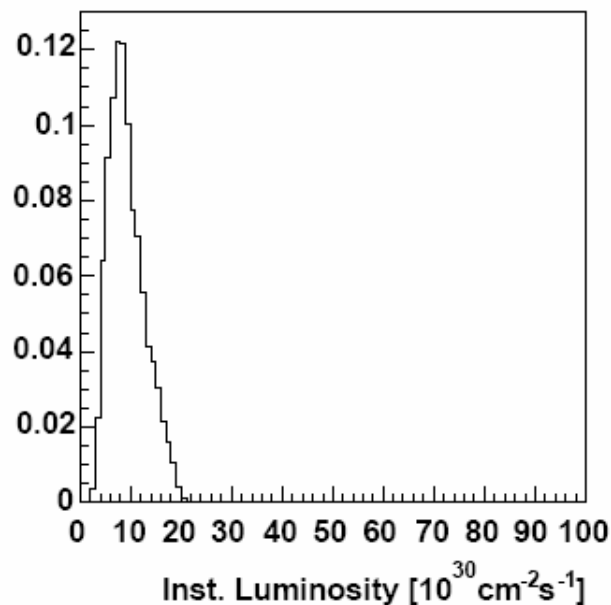
D=0.5:  $527 < P_T^{\text{MEAN}} < 700 \text{ GeV/c}$

Mean 41.23  
RMS 37.18

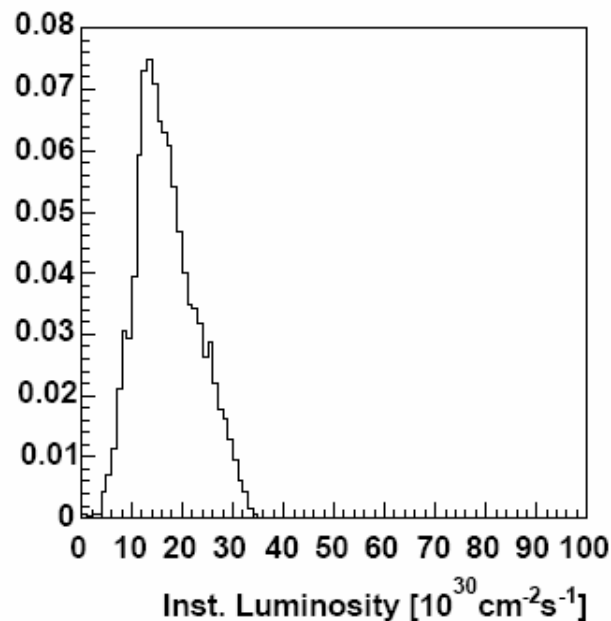


# 5 $\neq$ run ranges

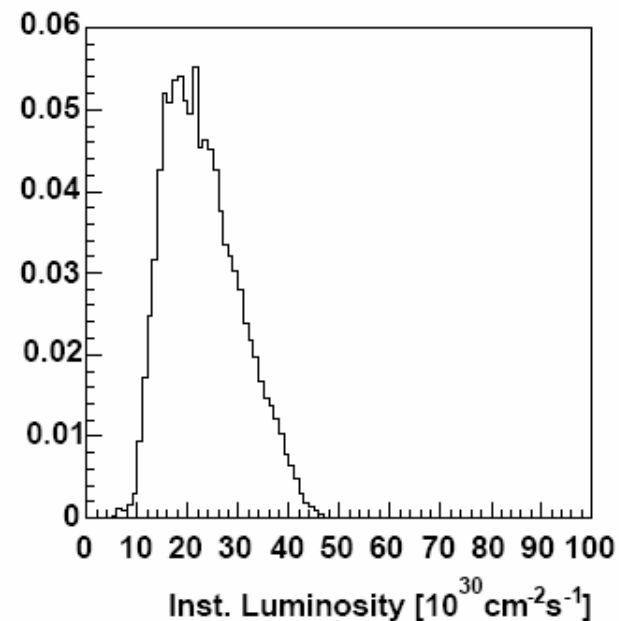
Range #1: Run < 146000  $\rightarrow$  15 pb<sup>-1</sup>



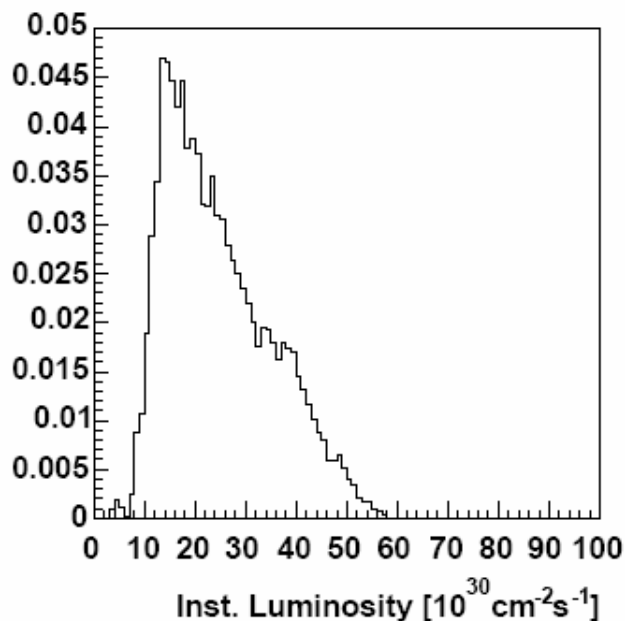
Range #2: 146000 < Run < 157000  $\rightarrow$  75 pb<sup>-1</sup>



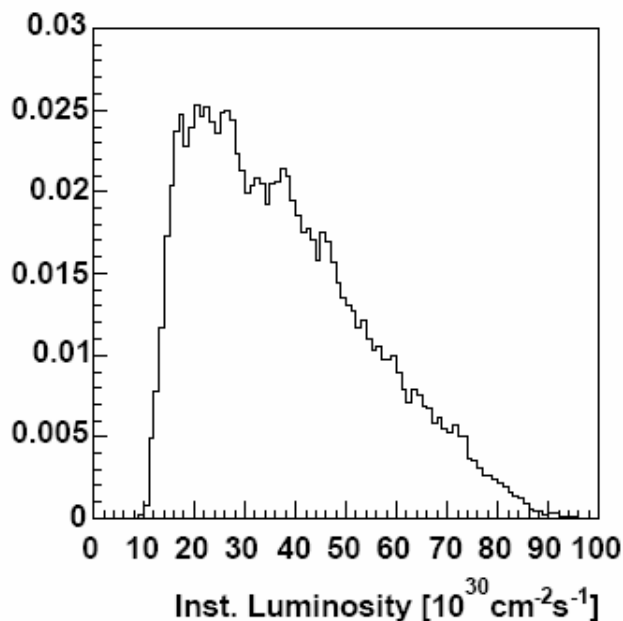
Range #3: 157000 < Run < 170000  $\rightarrow$  125 pb<sup>-1</sup>



Range #4: 170000 < Run < 180000  $\rightarrow$  48 pb<sup>-1</sup>

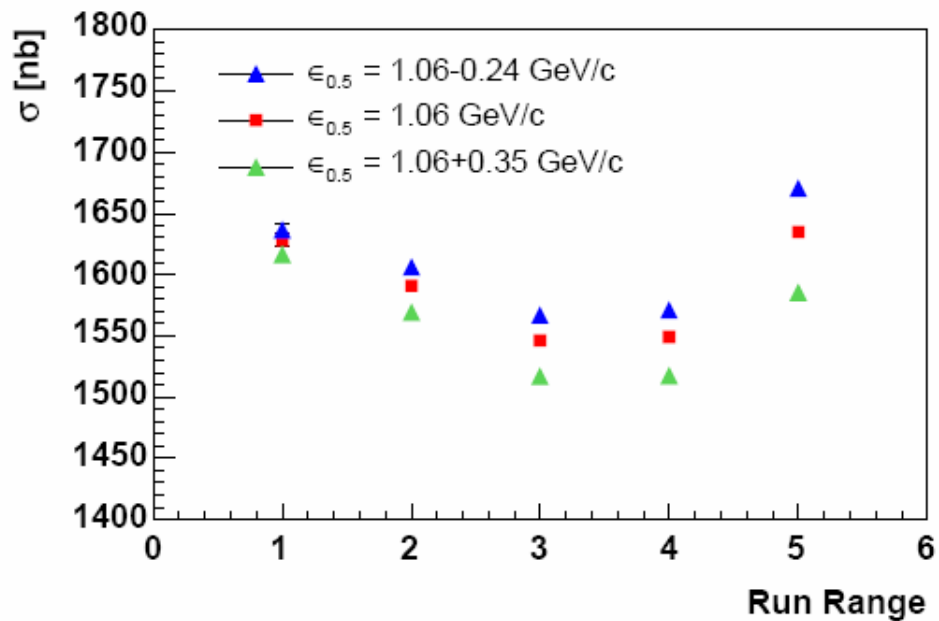


Range #5: Run > 180000  $\rightarrow$  115 pb<sup>-1</sup>

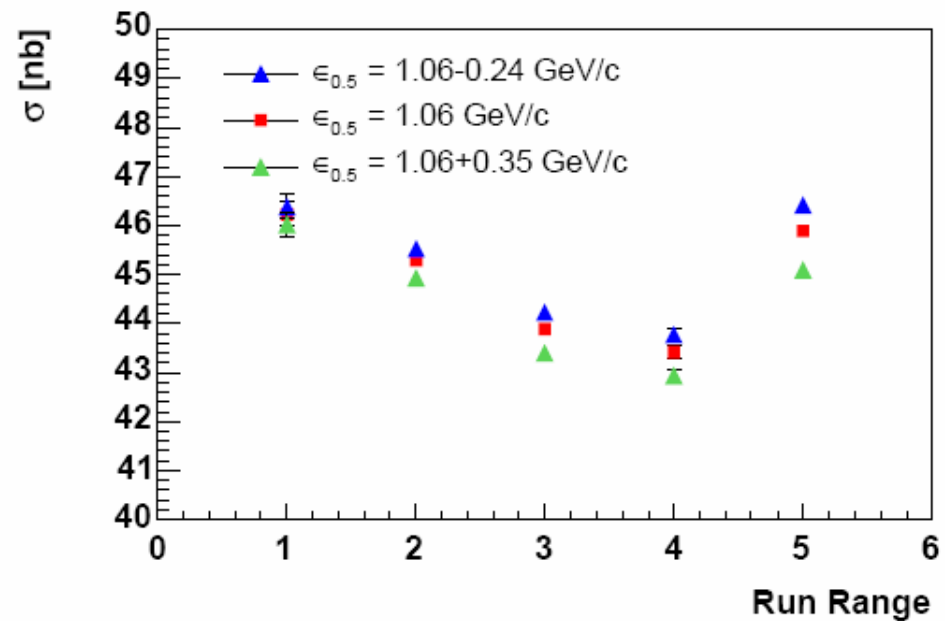


# $\sigma$ vs run ranges

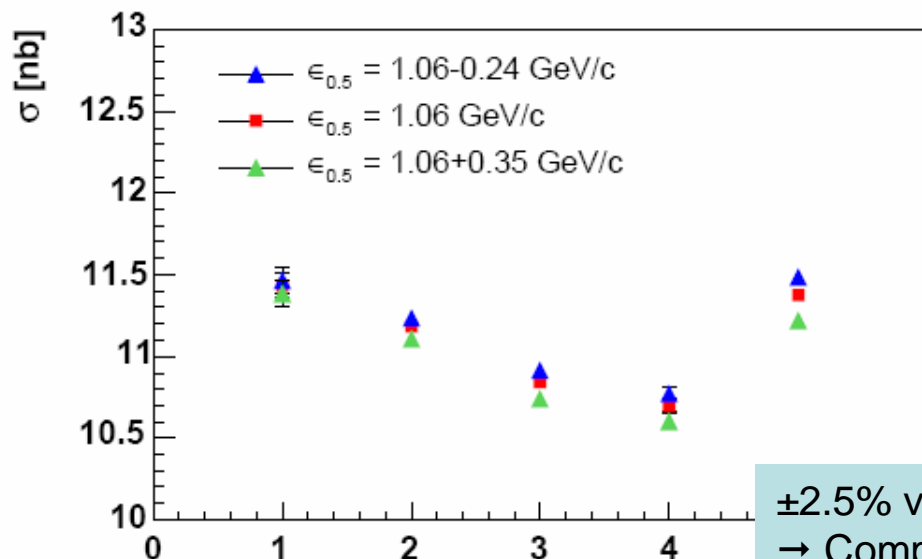
D=0.5 J20:  $\sigma$  for  $p_T^{\text{RAW}} > 27 \text{ GeV/c}$



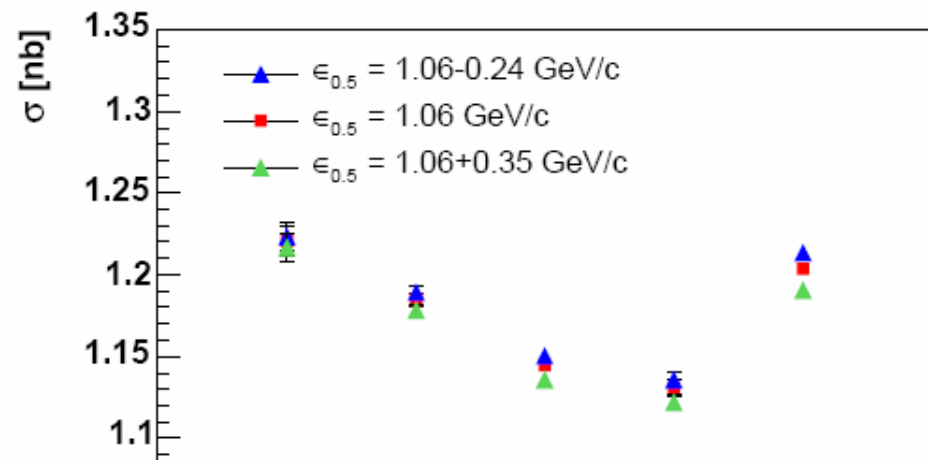
D=0.5 J50:  $\sigma$  for  $p_T^{\text{RAW}} > 62 \text{ GeV/c}$



D=0.5 J70:  $\sigma$  for  $p_T^{\text{RAW}} > 83 \text{ GeV/c}$



D=0.5 J100:  $\sigma$  for  $p_T^{\text{RAW}} > 127 \text{ GeV/c}$

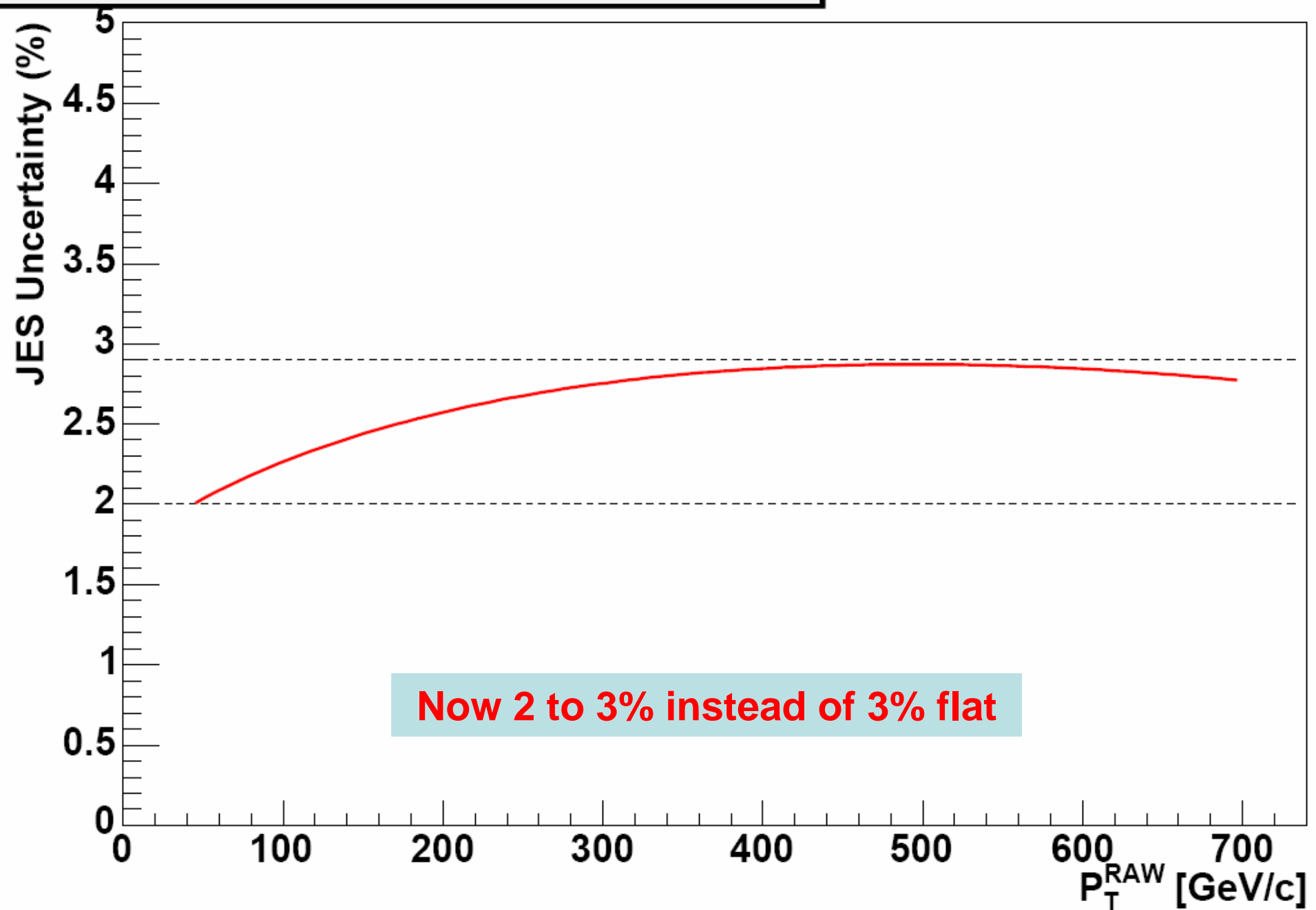


$\pm 2.5\%$  variations of the  $\sigma$  (same shape for the  $\neq P_T$  cuts)

→ Compatible with  $\pm 0.5\%$  time dependence of calorimeter calibrations

→ No real sensitivity to the Pile-Up correction

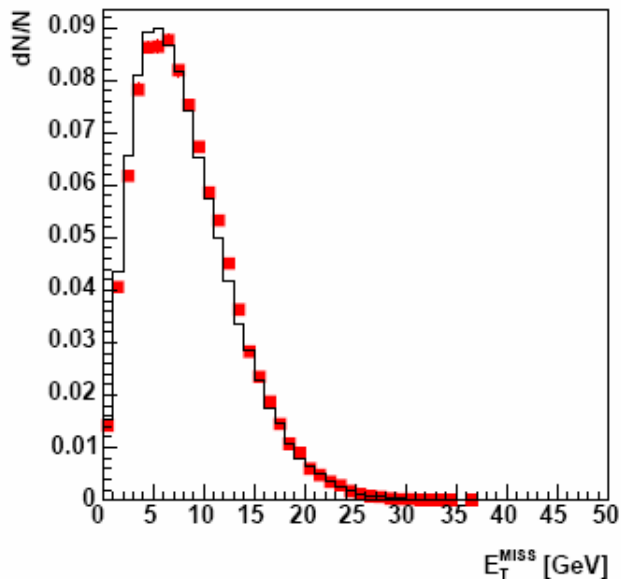
# JES Uncertainty (%) vs $P_T^{\text{RAW}}$ [GeV/c]



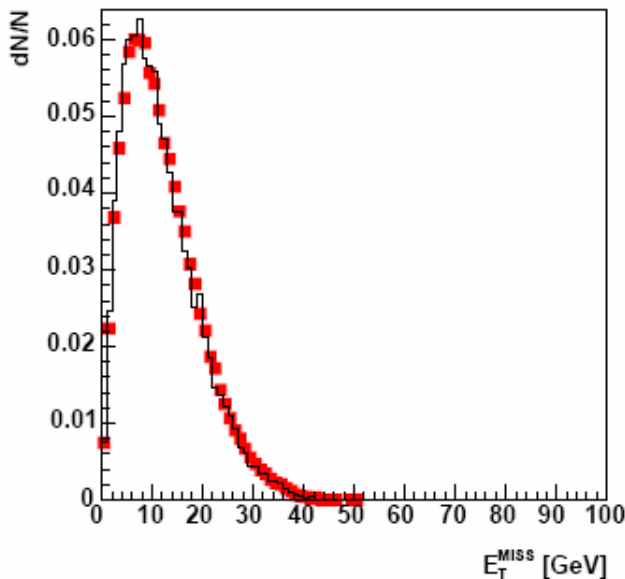
# Missing $E_T$ scale uncertainty

23

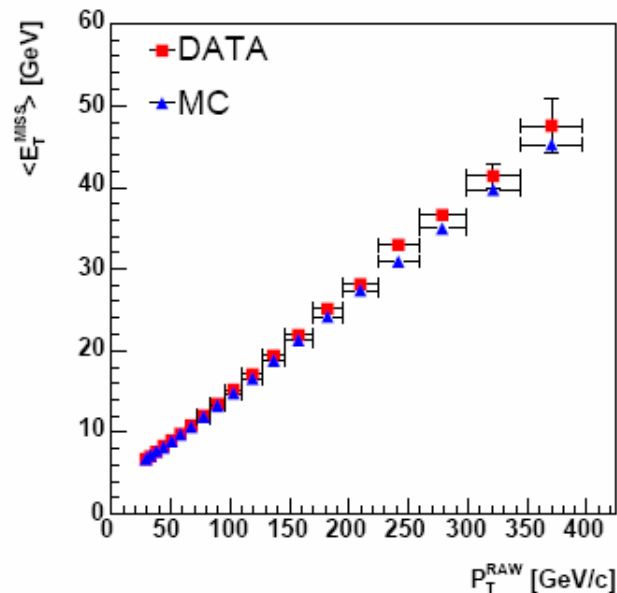
D=0.5:  $41 < P_T^{\text{RAW}} < 47 \text{ GeV/c}$



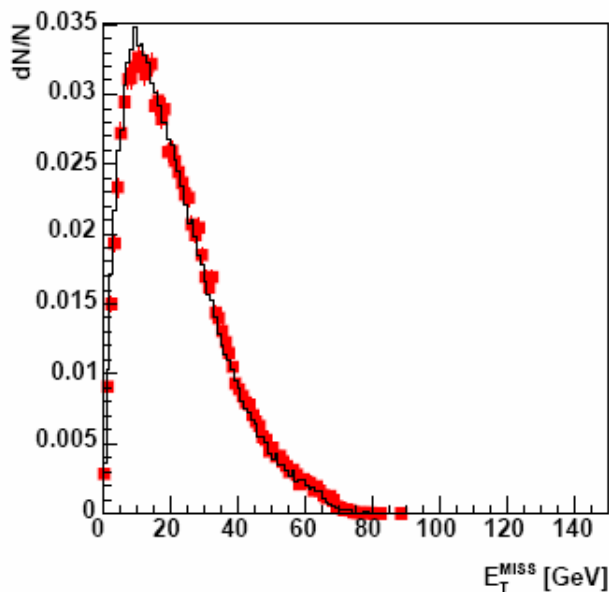
D=0.5:  $72 < P_T^{\text{RAW}} < 83 \text{ GeV/c}$



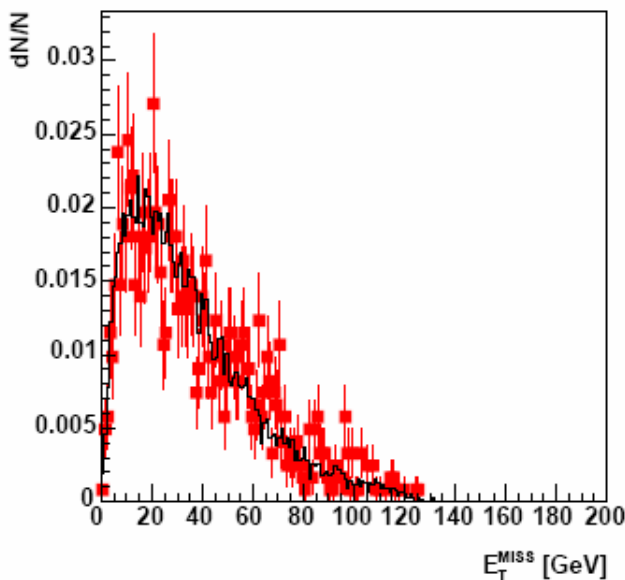
$\langle E_T^{\text{MISS}} \rangle$  vs  $P_T^{\text{RAW}}$  (D=0.5)



D=0.5:  $146 < P_T^{\text{RAW}} < 169 \text{ GeV/c}$



D=0.5:  $259 < P_T^{\text{RAW}} < 298 \text{ GeV/c}$



$\langle E_T^{\text{MISS}} \rangle$ : DATA / MC vs  $P_T^{\text{RAW}}$  (D=0.5)

